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F00 BIT  
OPTIMIZATION  
PROJECT

SMITH INTERNATIONAL,  
INC.

# ORCA Insert

## FEATURES

- Oblong insert bottom

- Counter Insert Rotation

- Improved Strength

Rotated and Offset Crest (.680  
crest width)

- Optimized Scraping Action

- Improved Strength

# IDEAS Results

## DUCTILE ROCK

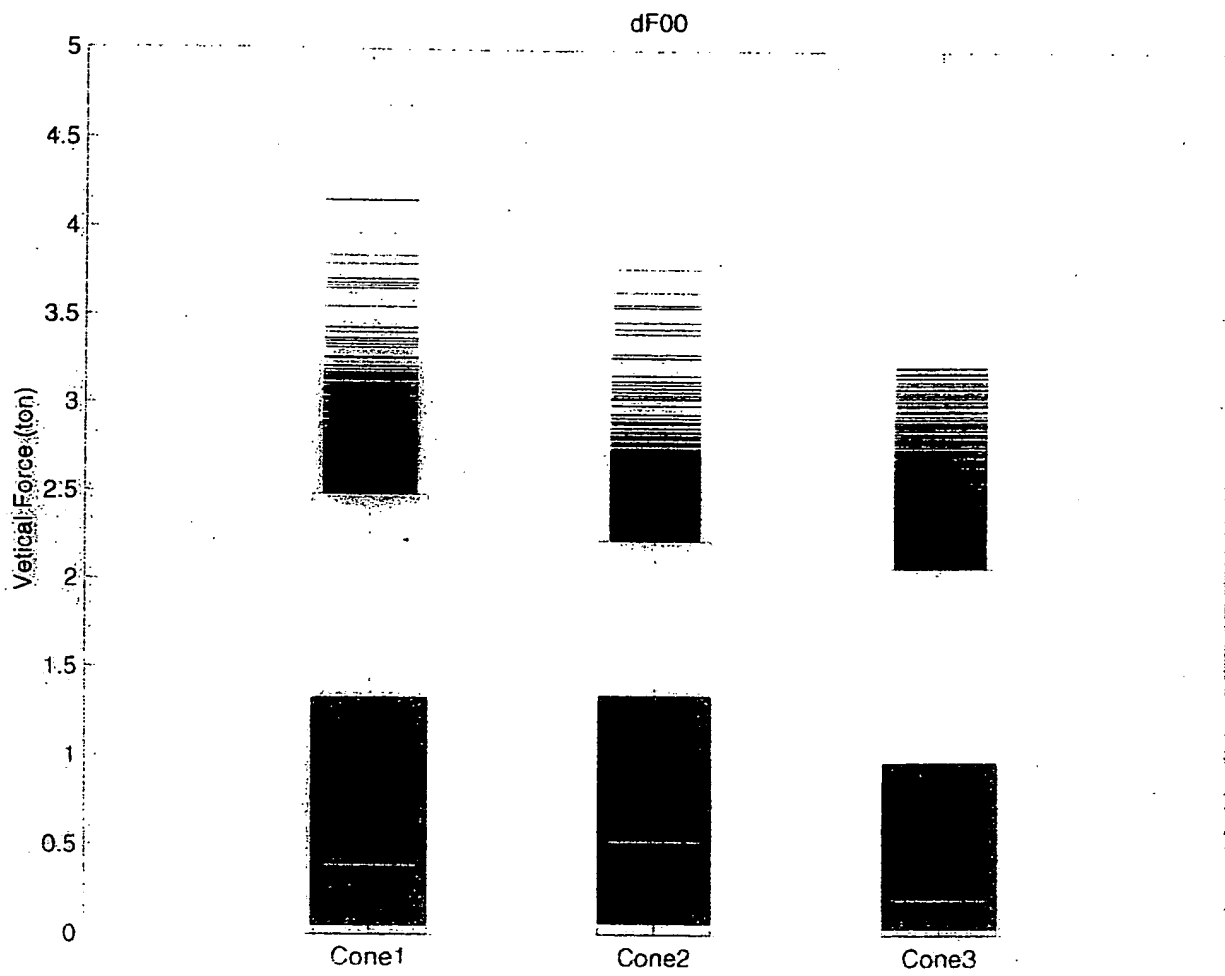
R.O.P.=25.47 m/hr (2.6 %  
higher)

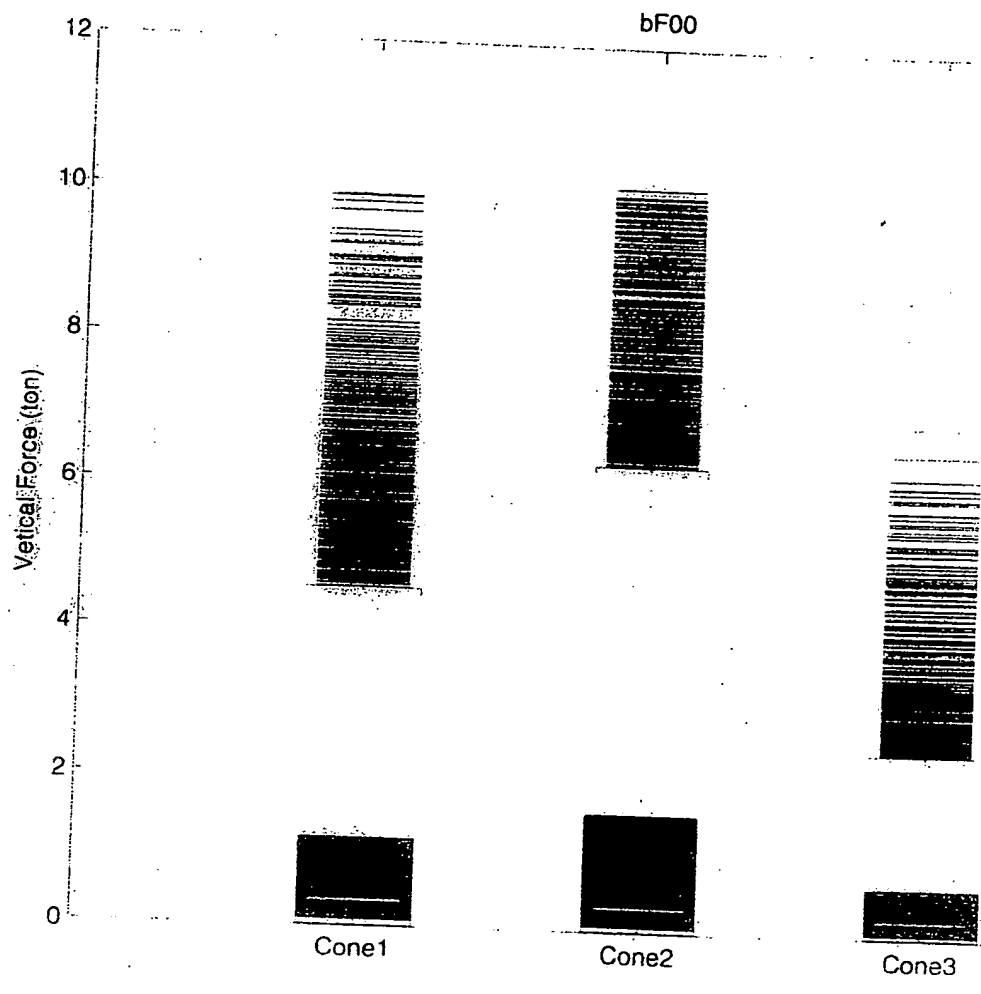
COVERAGE=55.14 % (1.6 %  
lower)

## BRITTLE ROCK

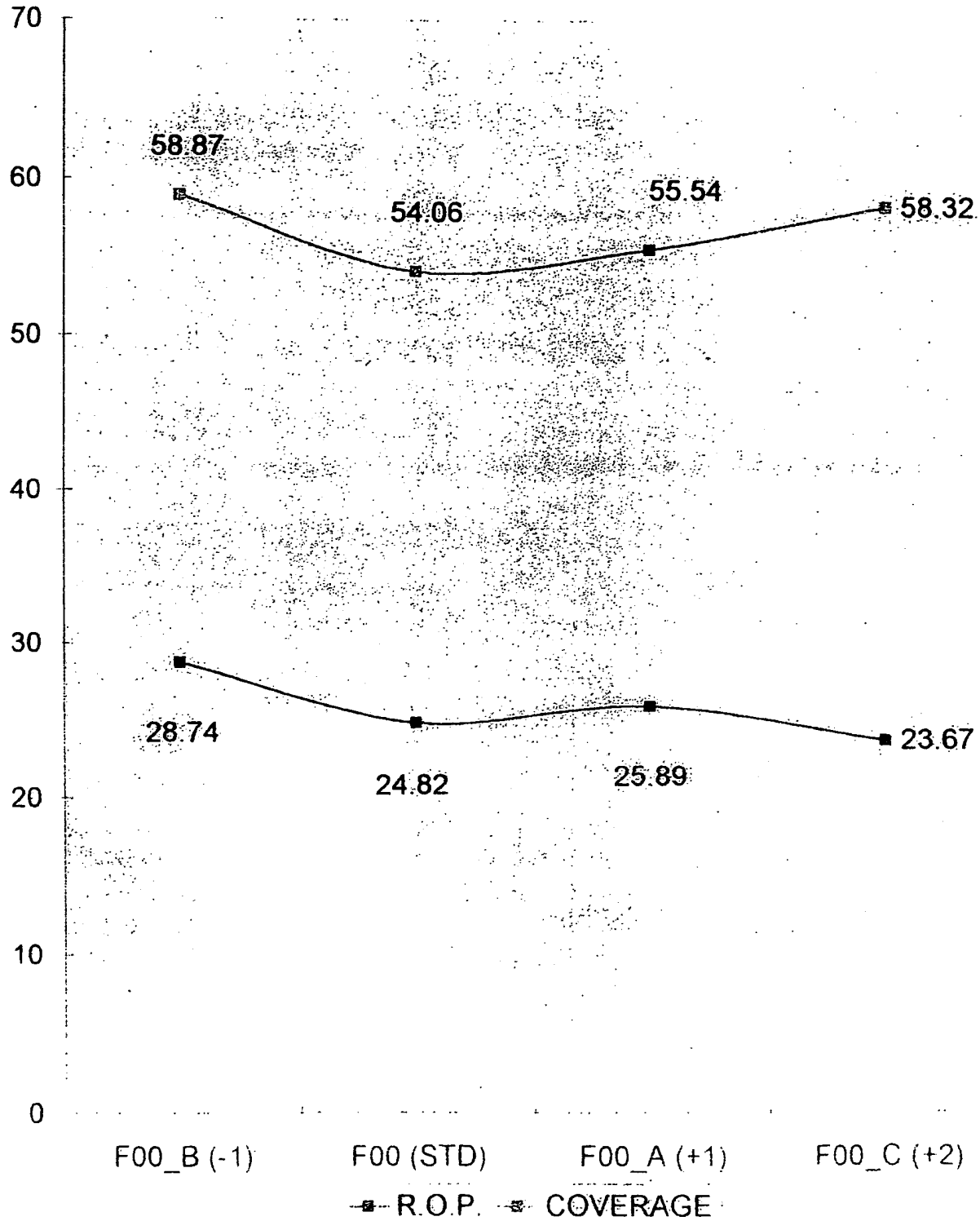
R.O.P.=24.45 m/hr (9.3 %  
lower)

COVERAGE=36.70 % (7.3 %  
lower)

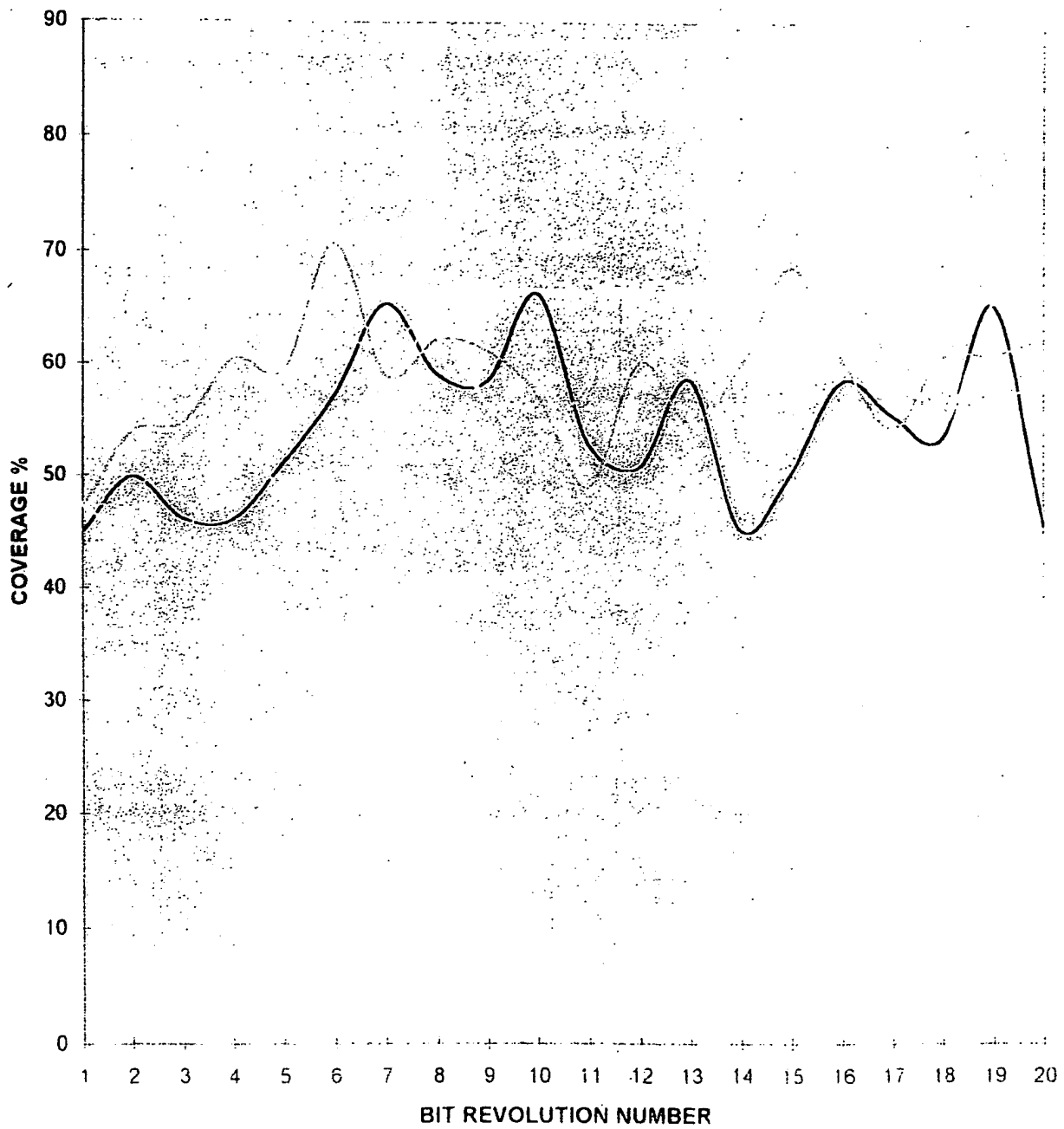




# EFFECT OF CHANGING INSERT COUNTS IN DUCTILE ROCK FOR F00 BIT



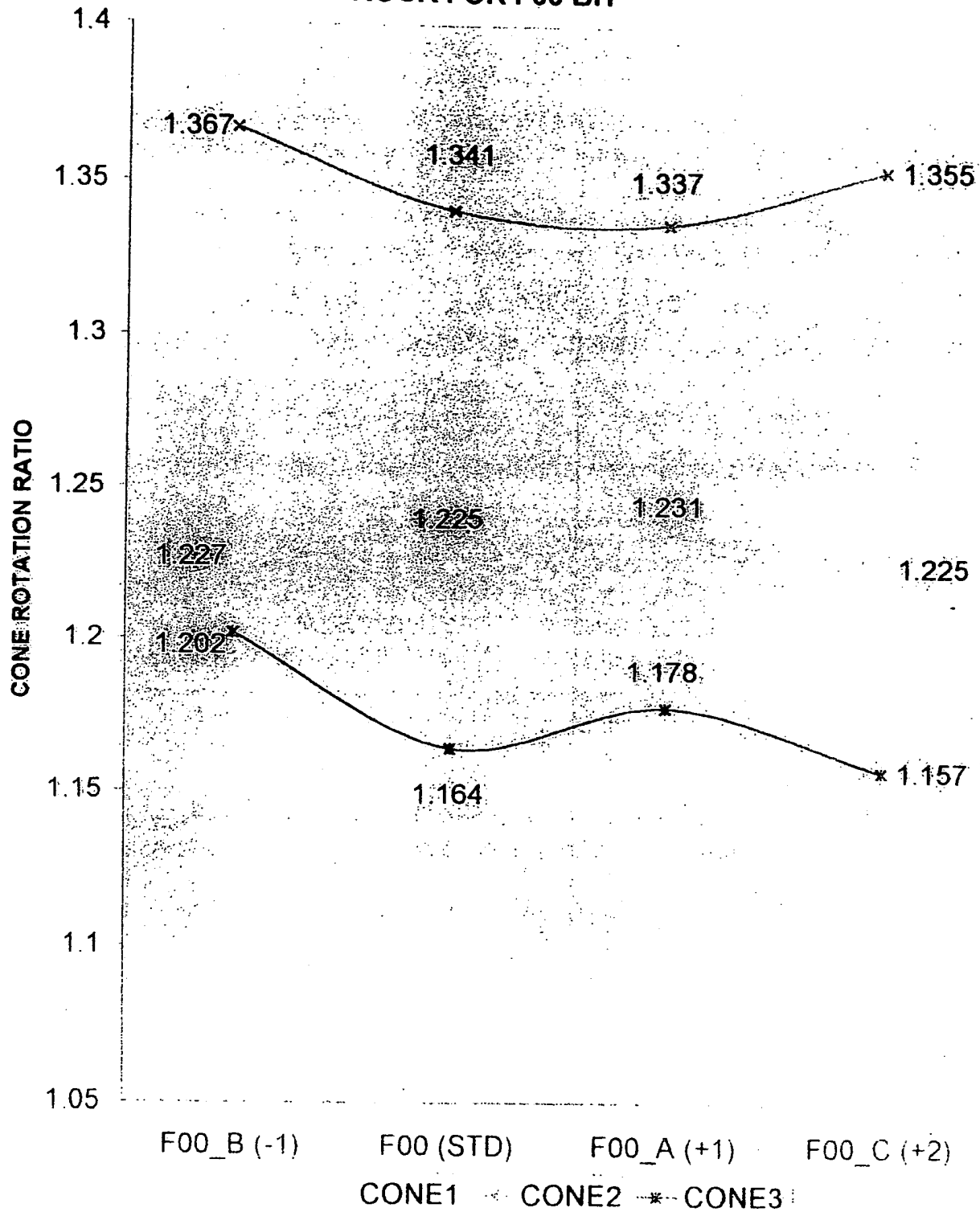
# EFFECT OF CHANGING INSERT COUNTS ON COVERAGE IN DUCTILE ROCK



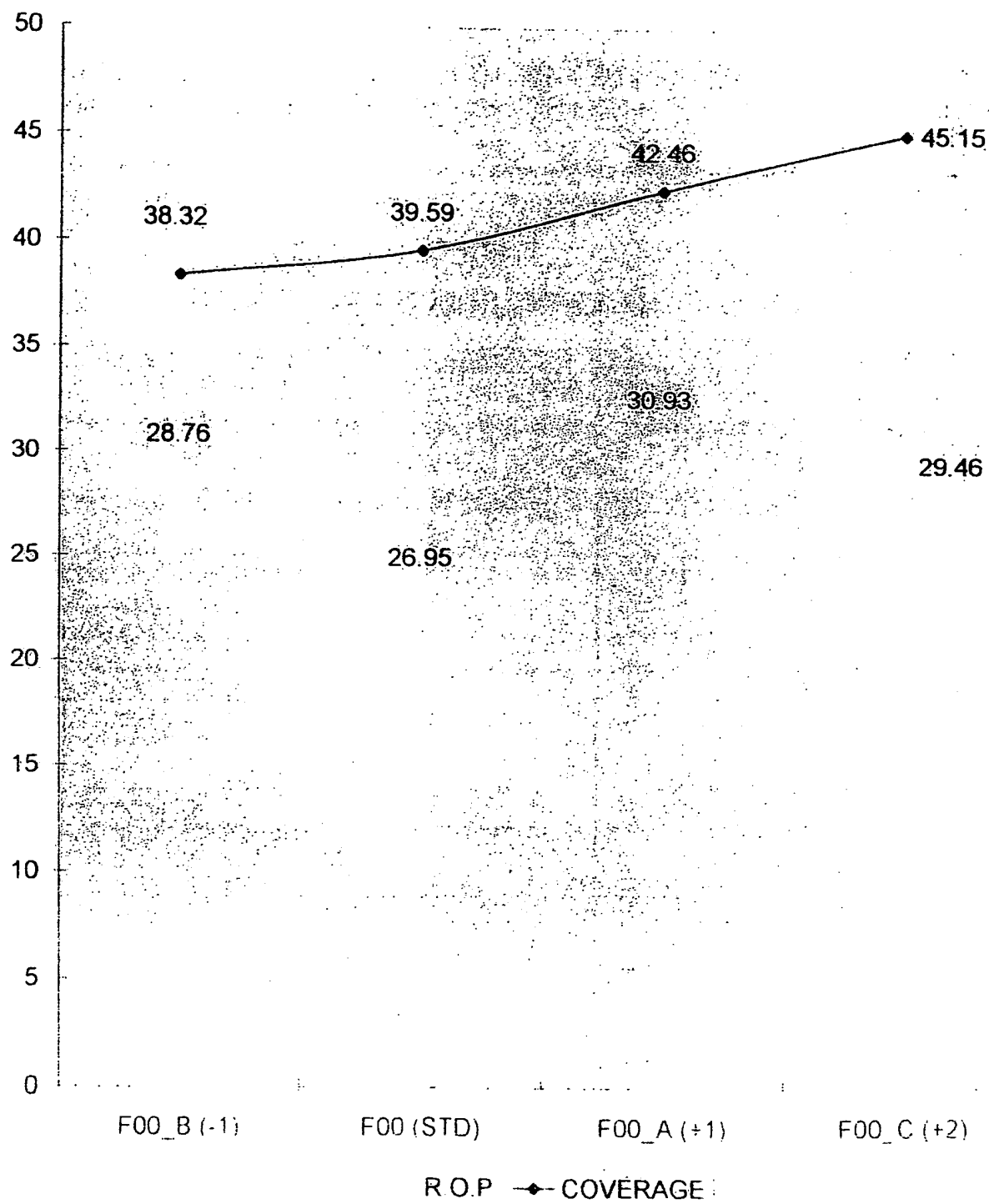
— F00      F00\_A      F00\_B      F00\_C



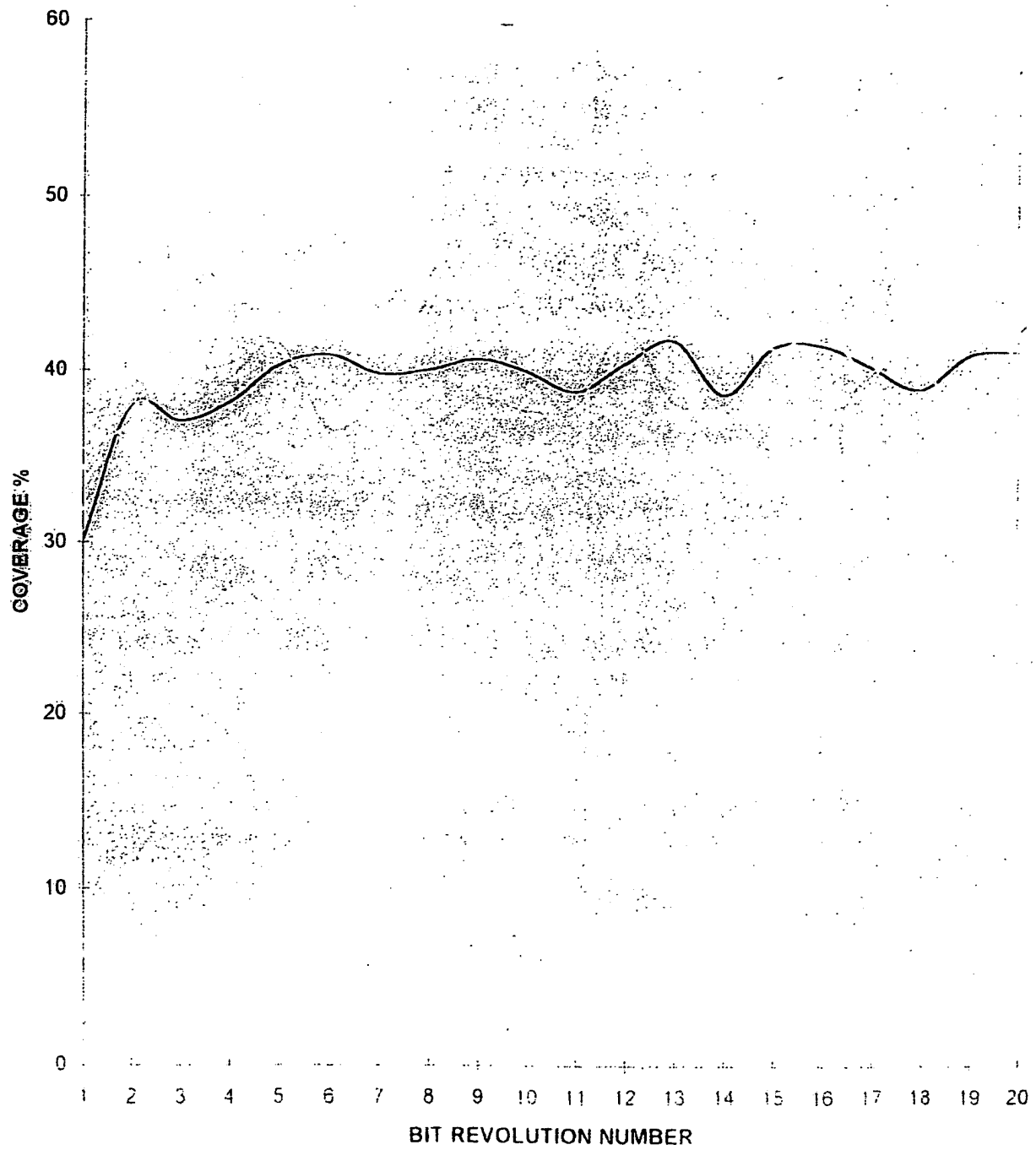
# EFFECT OF CHANGING INSERT COUNTS IN DUCTILE ROCK FOR F00 BIT



# EFFECT OF CHANGING INSERT COUNTS IN BRITTLE ROCK FOR F00 BIT

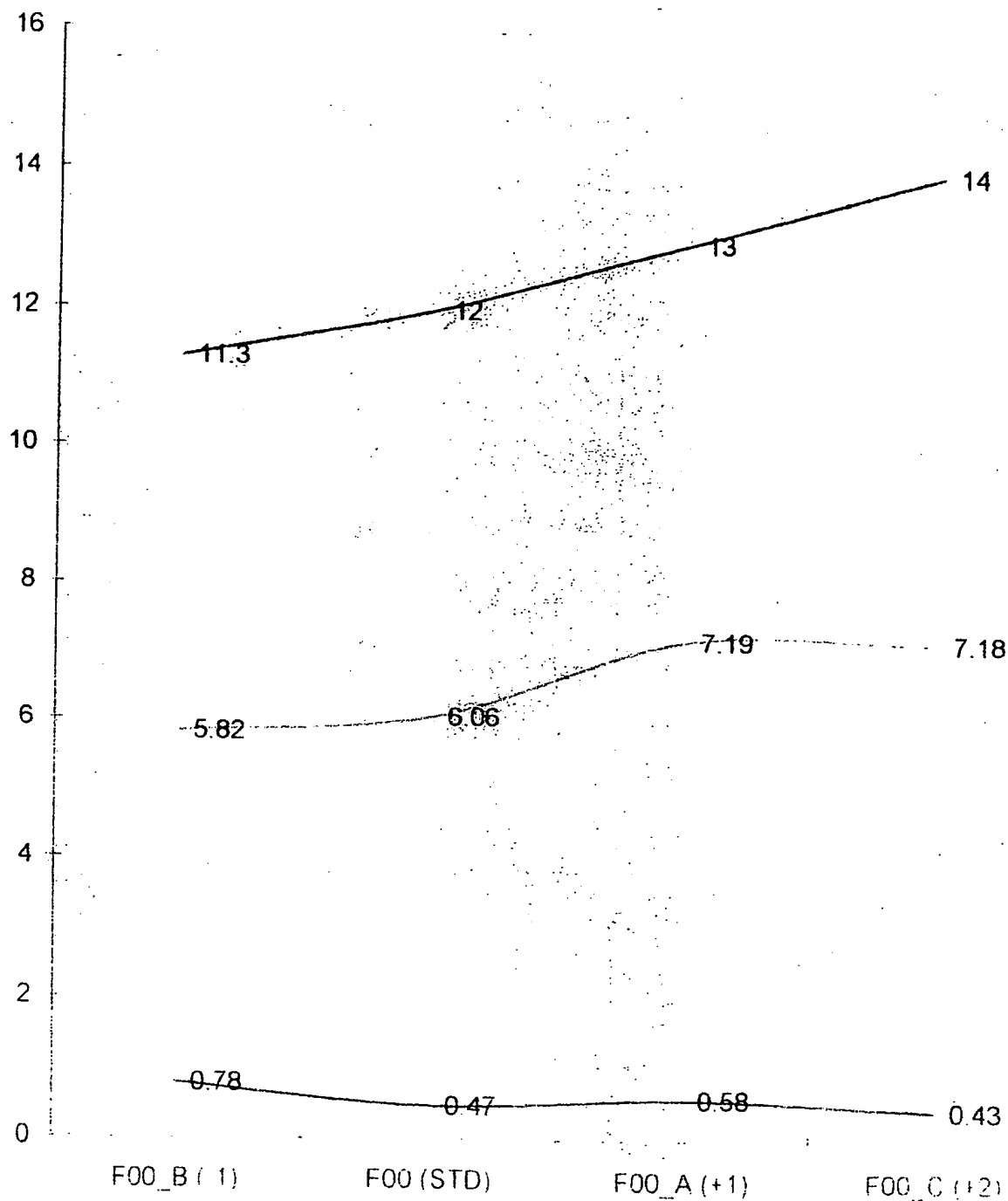


# EFFECT OF CHANGING INSERT COUNTS ON COVERAGE IN BRITTLE ROCK



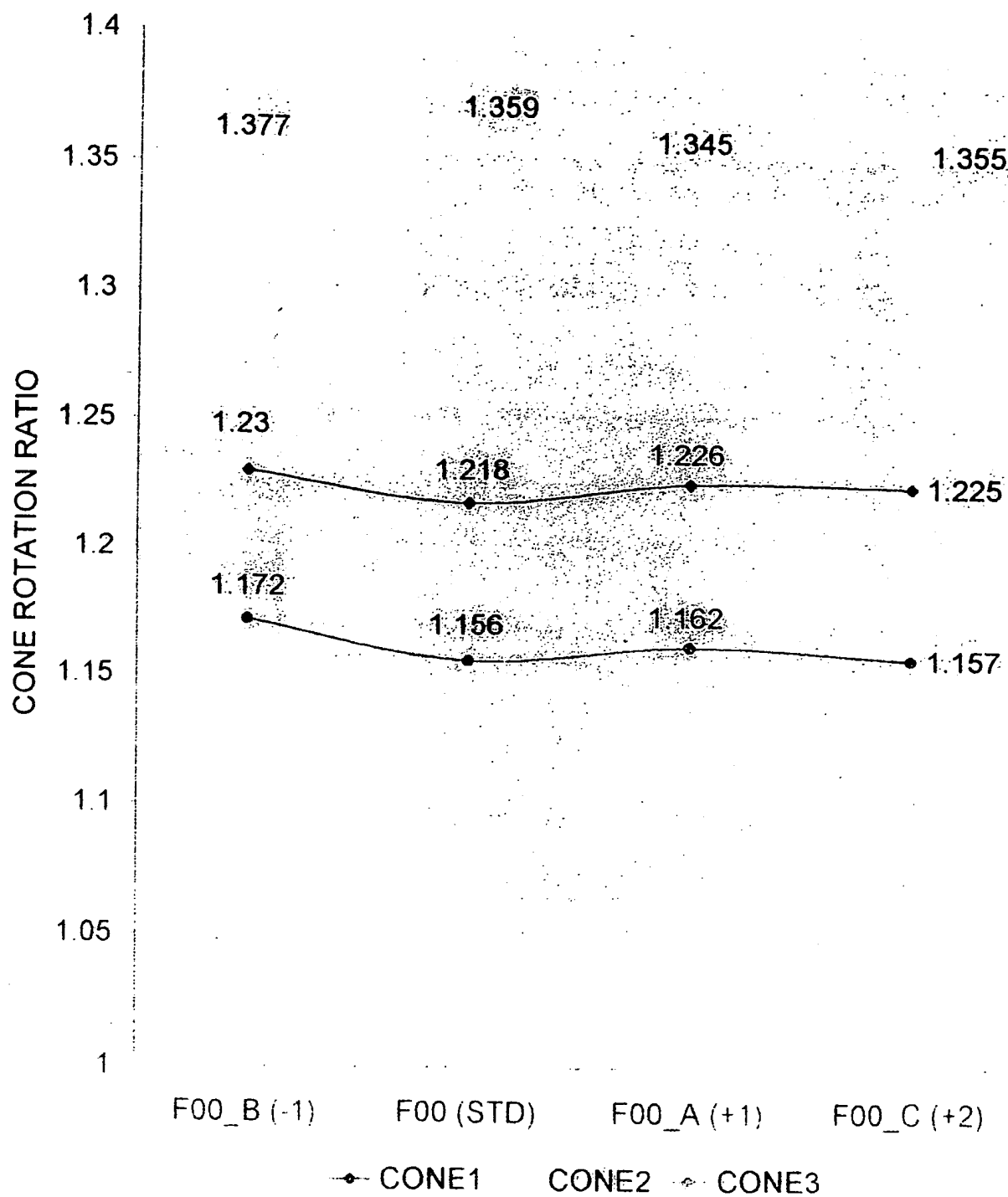
— F00    - - - F00\_A    . . . F00\_B    - . - F00\_C

# EFFECT OF CHANGING INSERT COUNTS IN BRITTLE ROCK FOR F00 BIT

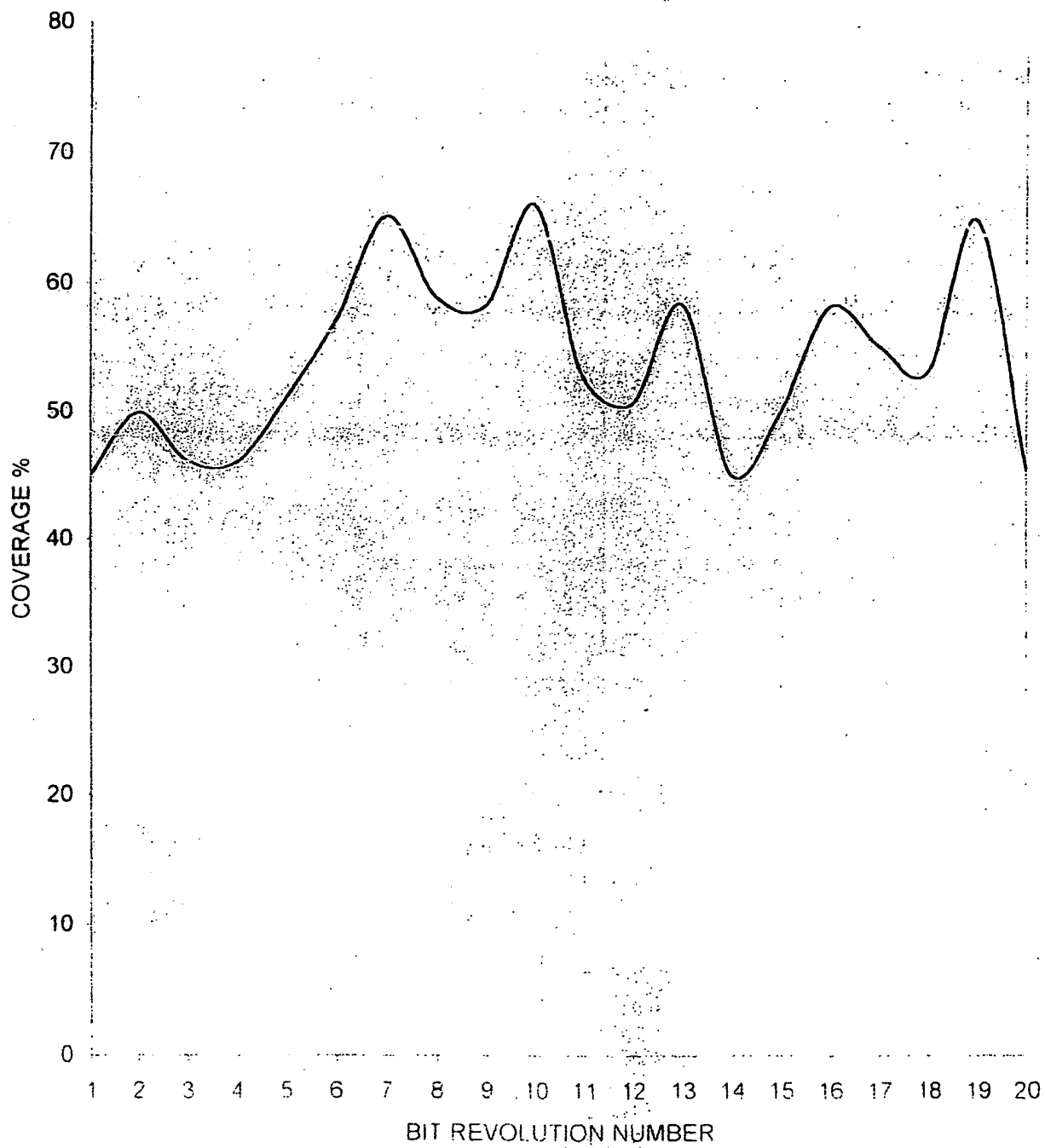


— BOHTEETH    BOHFRAC1    — BOHFRAC2

# EFFECT OF CHANGING INSERT COUNTS IN BRITTLE ROCK FOR F00 BIT

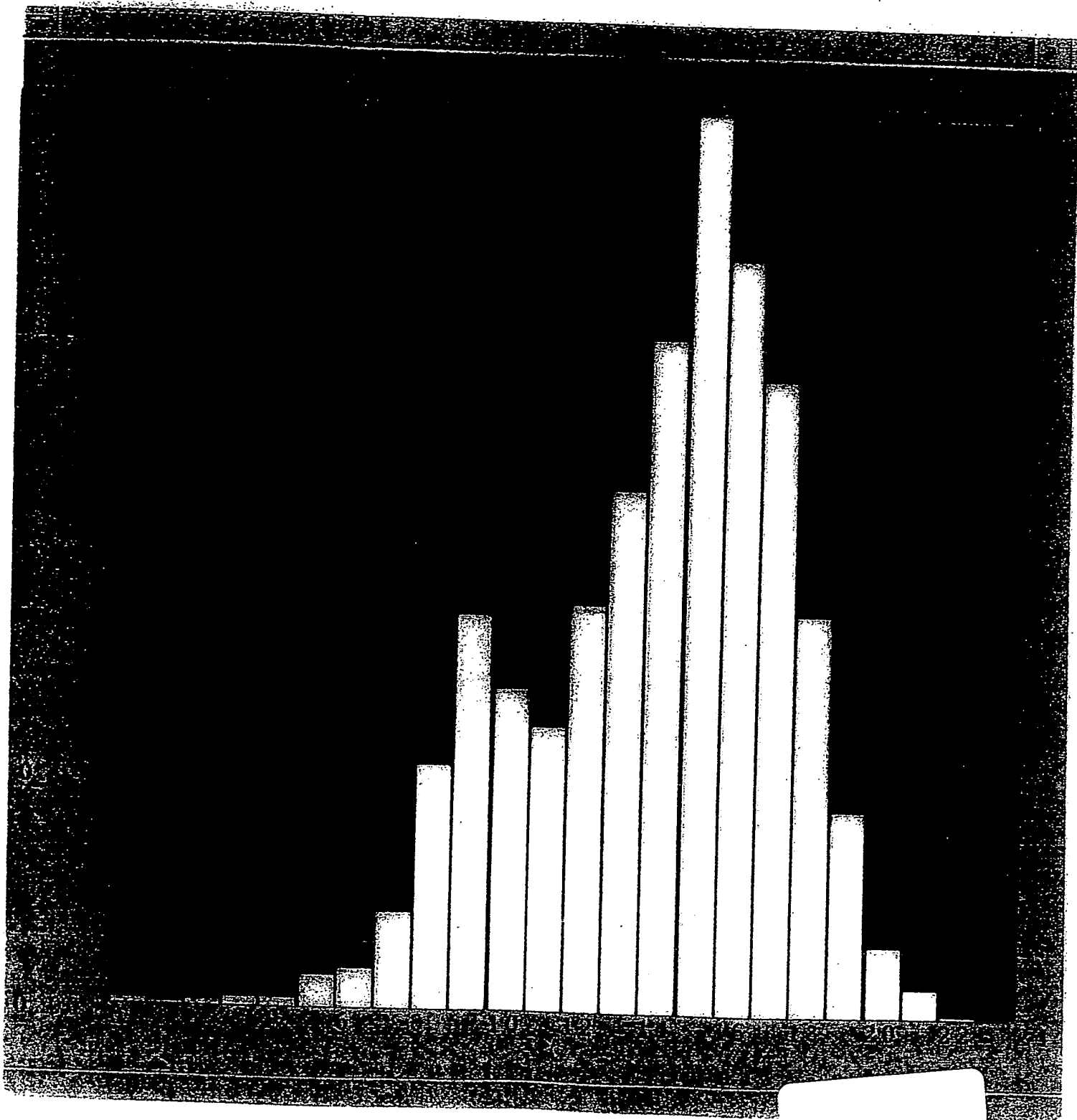


COVERAGE OF F00 BIT VERSUS F00-1 BIT (NEW C.S.) IN DUCTILE ROCK

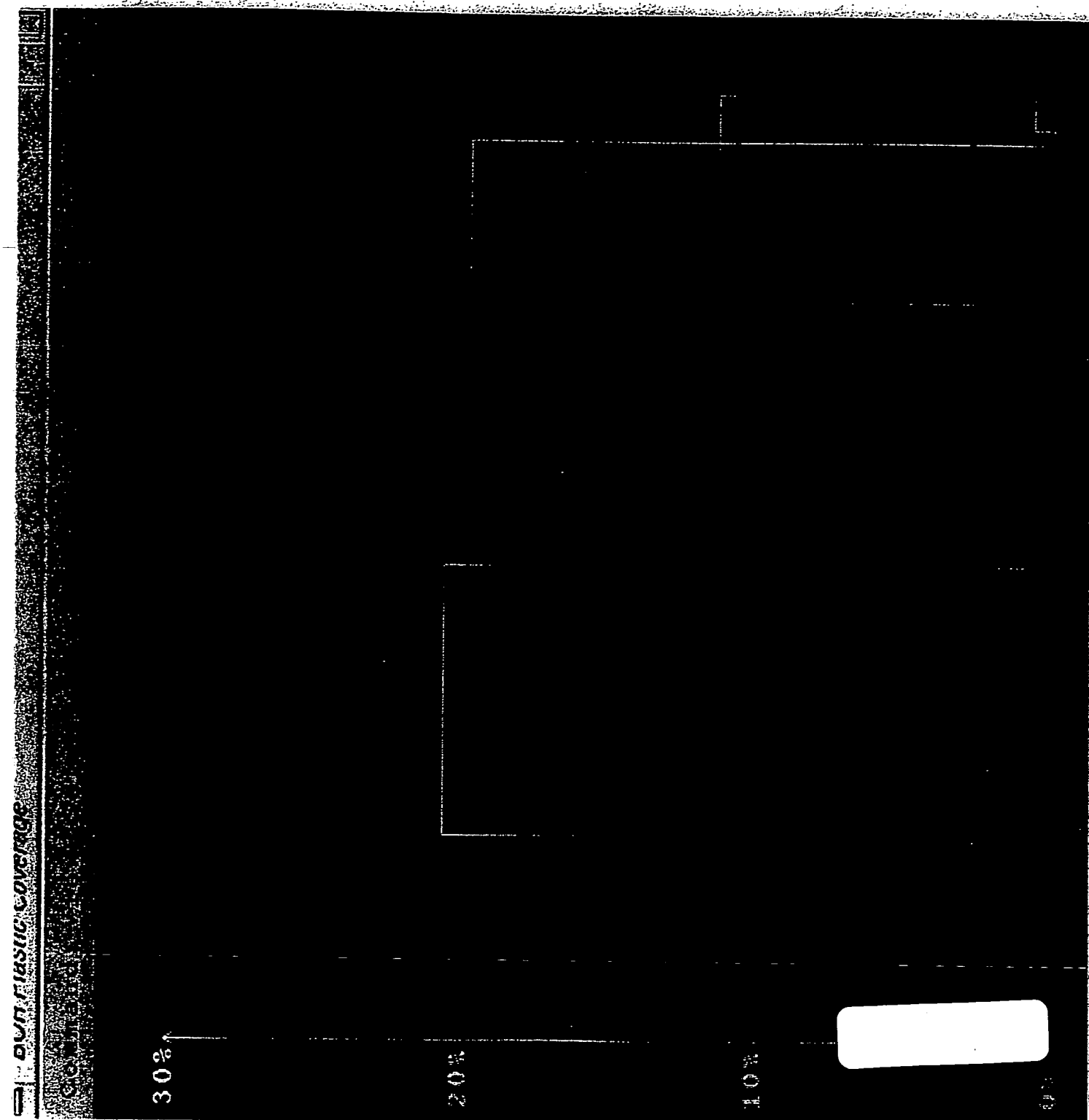


— F00      F00-1 STD

**BIT TYPE:**  
**ROCK: DUCTILE**

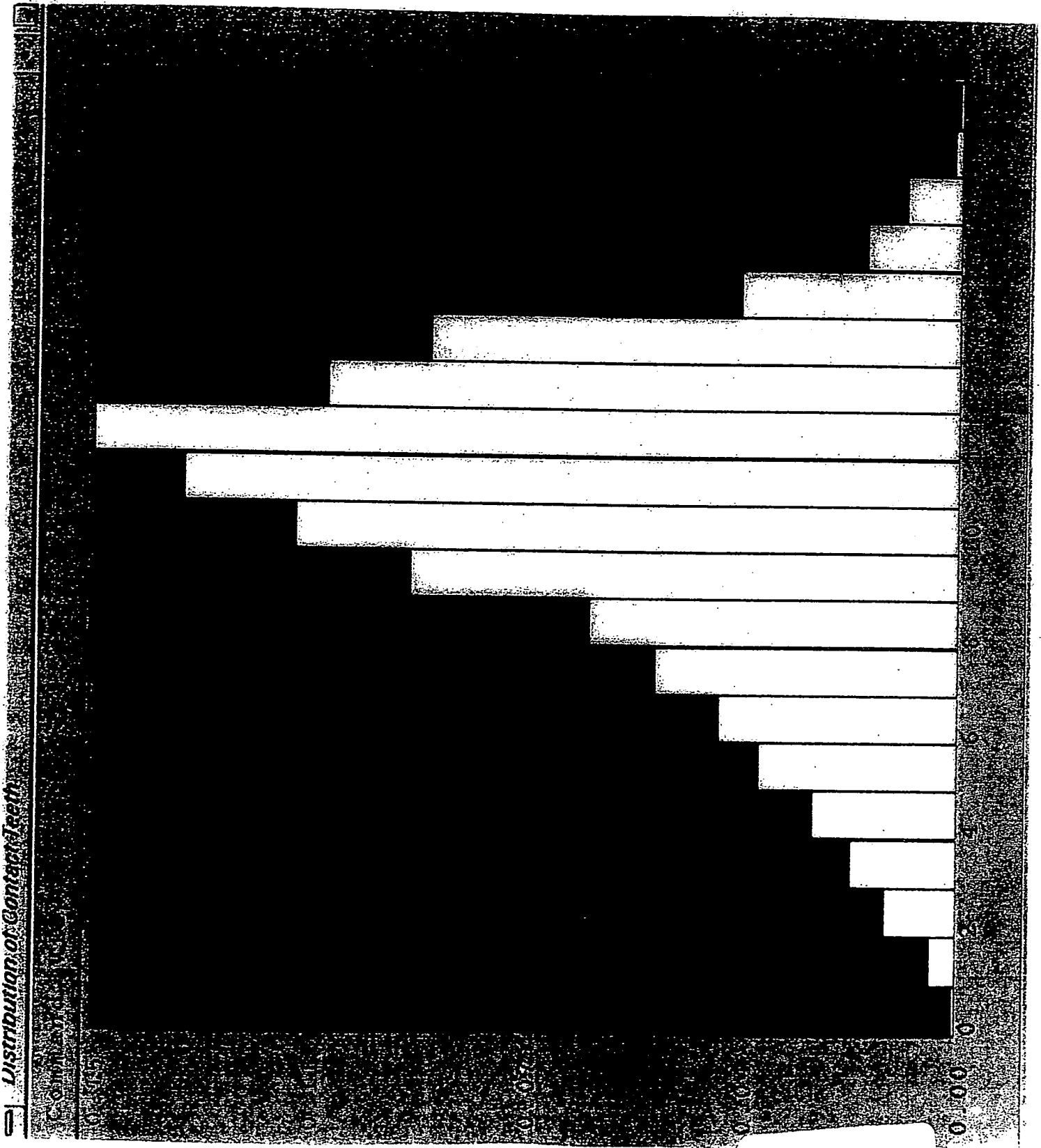


**BIT TYPE: F00-1 STD**  
**ROCK: BRITTLE**

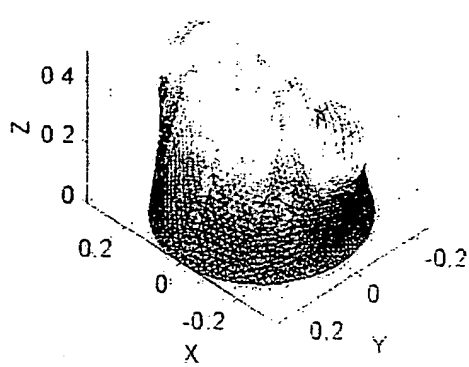
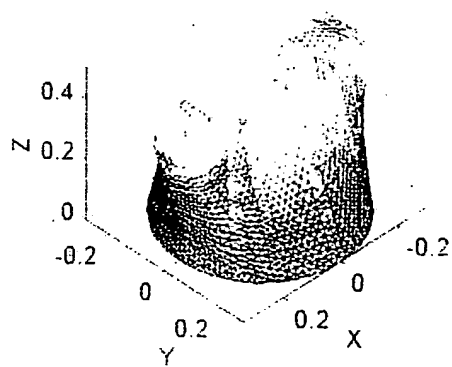
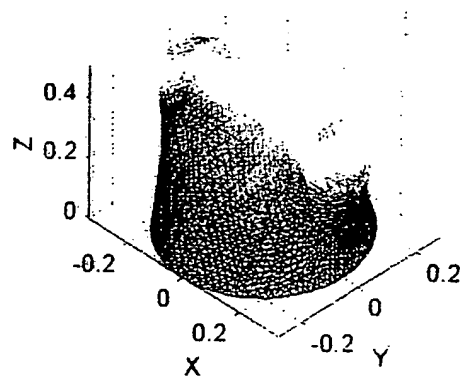
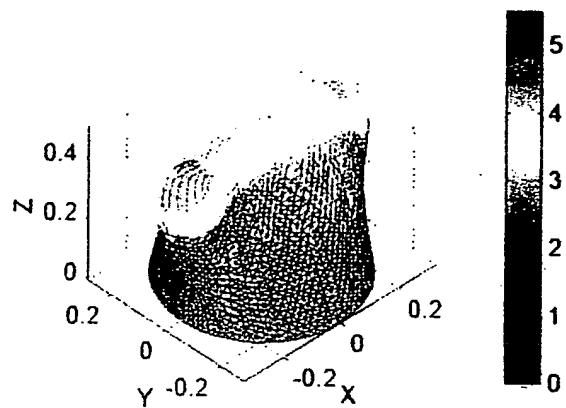




BIT TYPE: *4 1/2" - 5 1/2"*  
ROCK: BRITTLE

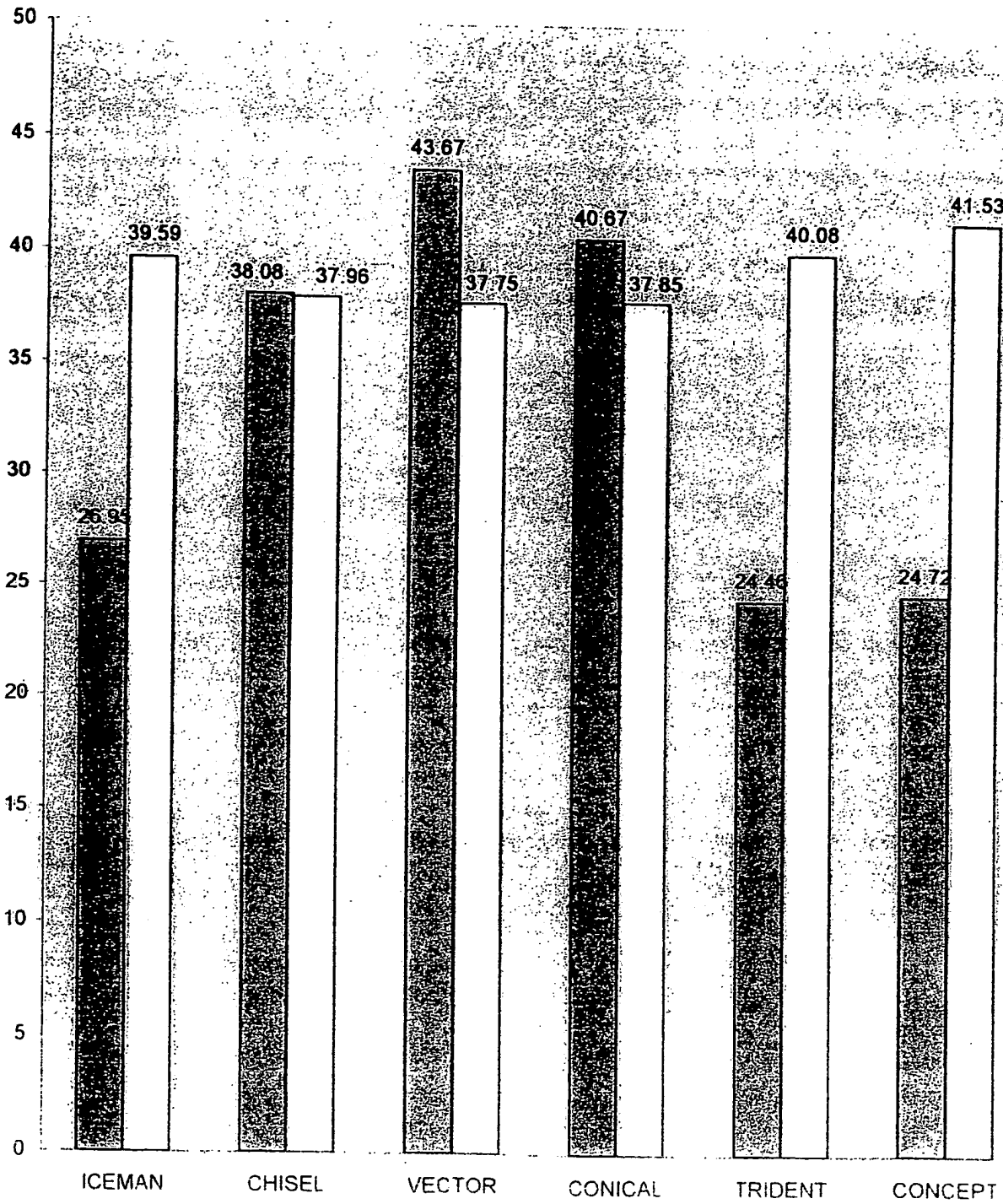


bF00-1B Cumulative Cutting (log<sub>10</sub> mm)

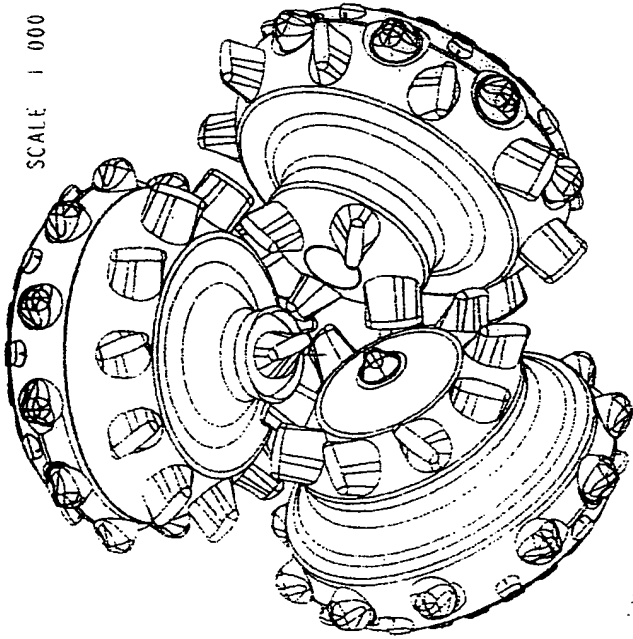


# COMPARISON OF INSERT SHAPES IN BRITTLE ROCK

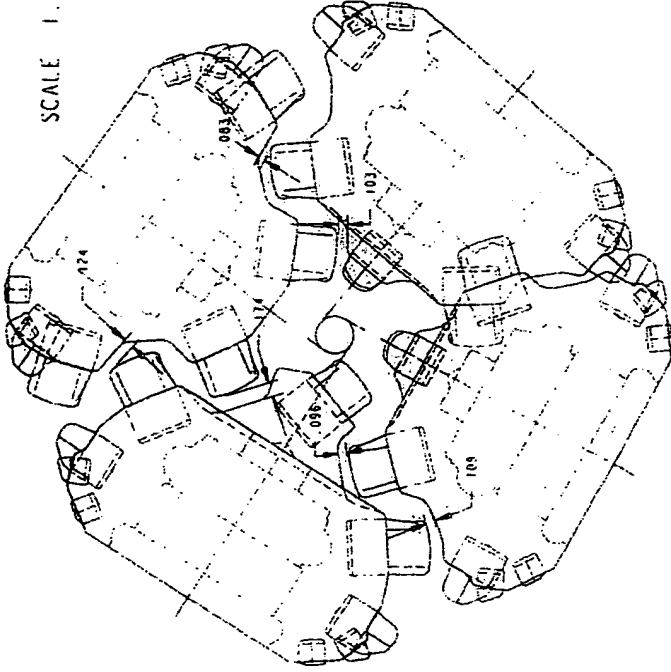
■ R.O.P. □ COVERAGE



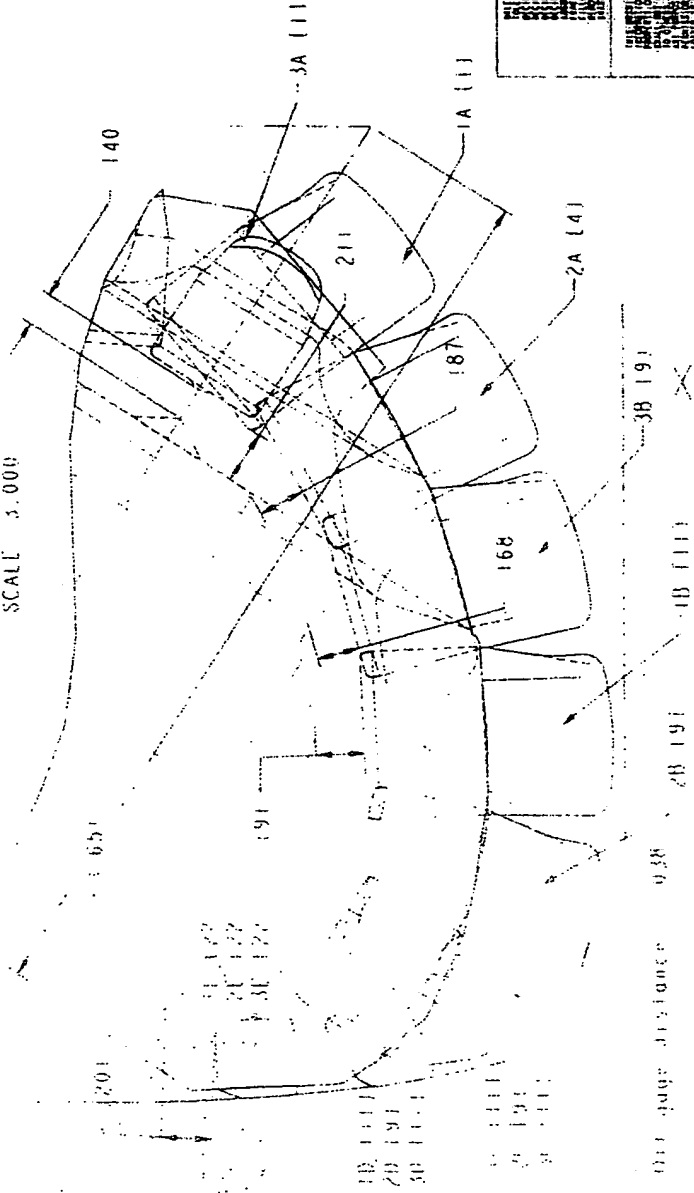
SCALE 1:000



SCALE 1:000



SCALE 3:000



NAME	ROW	INSERT	COUNT	PITCH	TYPE	DIA/WIDTH	LENGTH	EXT	GRIP	GRADE
CONC1	A	ORCA	1		ORCA	3525	675	310	400	518
	B	ORCA	1		ORCA	3525	675	310	400	518
	C	R-GAGE	1		R-GAGE	3525	675	310	410	510
	D	ORCA	1		SIC	3125		160	240	411
CONC2	A	ORCA	22		SIC	3125		160	240	411
	B	ORCA	4		ORCA	3525	675	310	430	516
	C	R-GAGE	8		R-GAGE	3525	675	310	430	516
	D	ORCA	8		SIC	3125		160	240	411
CONC3	A	ORCA	22		SIC	3125		160	240	411
	B	ORCA	4		ORCA	3525	675	310	430	516
	C	R-GAGE	8		R-GAGE	3525	675	310	430	516
	D	ORCA	8		SIC	3125		160	240	411

PART NUMBER L1077-ORCA

**SMITH TOOL**

DIVISION OF Smith International, Inc.

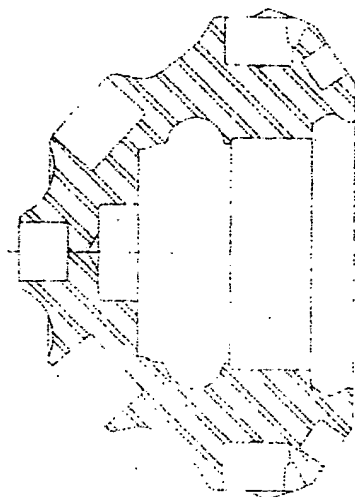
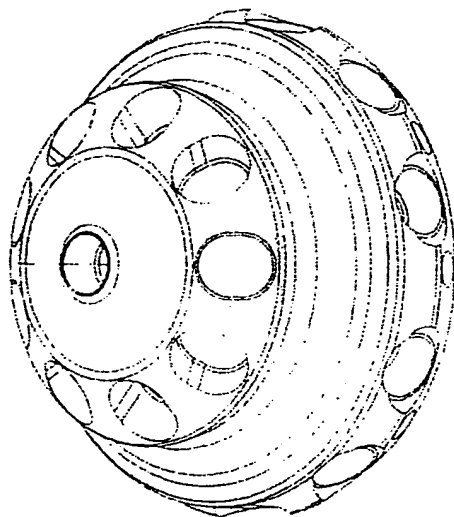
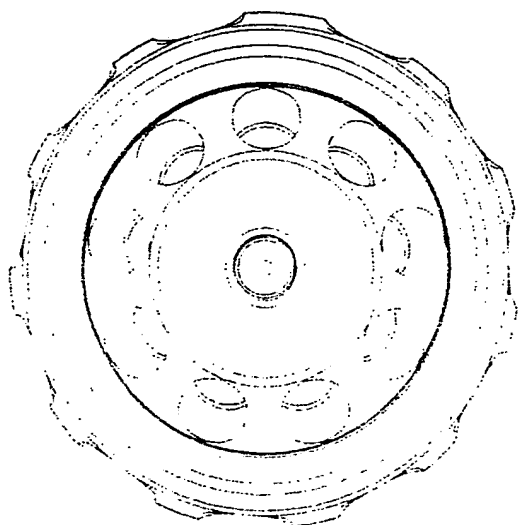
077 100 BIT LAYOUT  
ORCA INSERTS

SCALE: 0.3	MODEL NAME: L1077-ORCA	SHEET: 1 OF 1
DATE: 4-Jun-98	DRAWING NO: DL1077-ORCA	REV: R1V

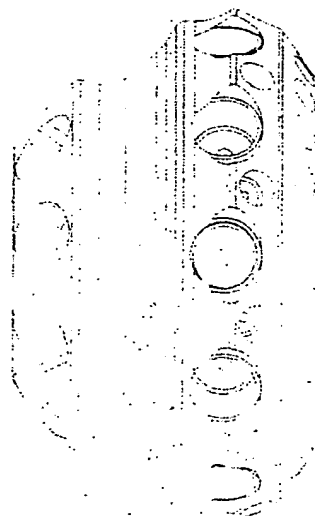
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ROW	COUNT	2D CL	3D CL	3D CL-S
A				
B	4	076		
C	11.45	358	12	081
D	11.45	716	25	
E	22	128		



SECTION A-A



PART NUMBER CONES  
**SMITH TOOL**

CONC H3  
PROFILE AND DRILLING

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STORAGE AND RETRIEVAL  
SYSTEM, WITHOUT THE WRITTEN  
PERMISSION OF SMITH TOOL  
COMPANY

REV	DATE	BY	DATE	BY	DATE	BY
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# Insert Retention Tests

## ■ Oblong inserts

— .675 length, .5625 width, .450 grip

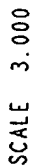
— .675 length, .5625 width, .480 grip

— .625 length, .5625 width, .450 grip

## ■ Standard inserts

— .5625 diameter, .480 grip

— .5625 diameter, .450 grip



Off gage distance = .038

NAME		ORCA-BIT								
ROW	INSERT	COUNT	PITCH	TYPE	DIA/MID	LENGTH	EXT	GRIP	GRADE	
CONE1	A	ORCA3	1	-	ORCA	.3125	.675	.510	.480	414
	B	ORCA3	1	-	ORCA	.3125	.675	.510	.480	414
	C	P-ORCA1	1	-	ORCA	.3125	.675	.510	.480	414
	D	P-ORCA2	1	-	P-ORCA	.3125	.675	.510	.480	414
	E	ORCA1	22	-	31C	.3125	.675	.510	.480	414
CONE2	A	ORCA1	22	-	31C	.3125	.675	.510	.480	414
	B	ORCA1	4	-	ORCA	.3125	.675	.510	.480	414
	C	P-ORCA1	5	-	ORCA	.3125	.675	.510	.480	414
	D	P-ORCA2	5	-	P-ORCA	.3125	.675	.510	.480	414
	E	ORCA1	22	-	31C	.3125	.675	.510	.480	414
CONE3	A	ORCA1	22	-	31C	.3125	.675	.510	.480	414
	B	ORCA1	4	-	ORCA	.3125	.675	.510	.480	414
	C	P-ORCA1	5	-	ORCA	.3125	.675	.510	.480	414
	D	P-ORCA2	5	-	P-ORCA	.3125	.675	.510	.480	414
	E	ORCA1	22	-	31C	.3125	.675	.510	.480	414

PART NUMBER: LT077-ORCA

# SMITH TOOL

**TOOL HILL**  
Division of Smith International Inc.

077 F00 BIT LAYOUT  
ORCA INSERTS

SCALE: 0.3	MODEL NAME: L1077-ORCA	SHEET: 1 OF 1	
SIZE	DRAWN DATE	DRAWING NO.	REV.
C AS	4-Jun-98	DLT077-ORCA	-

DLT077-ORCA



# IDEAS Results

## ■ DUCTILE ROCK

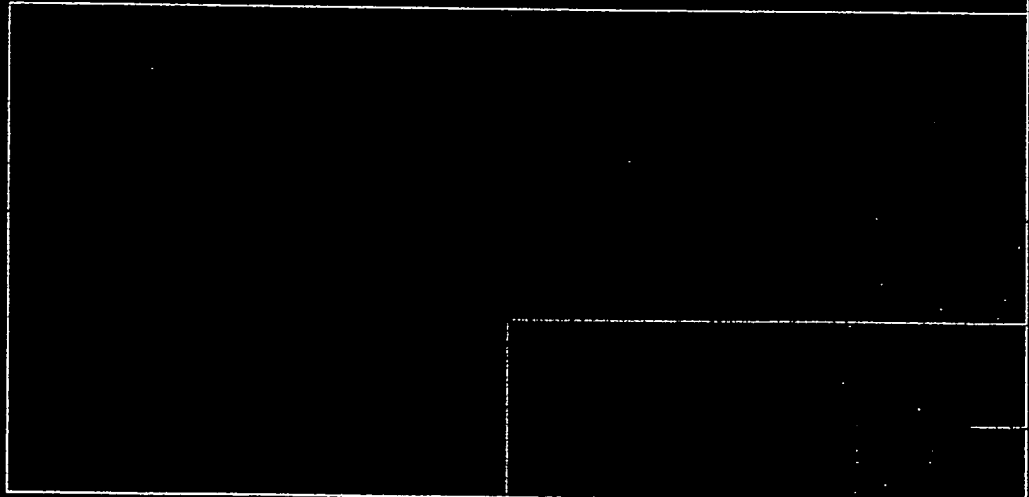
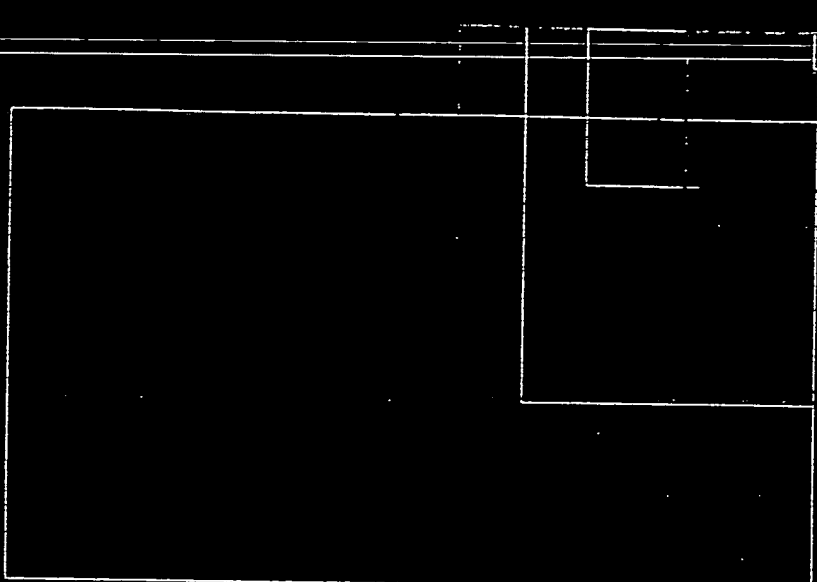
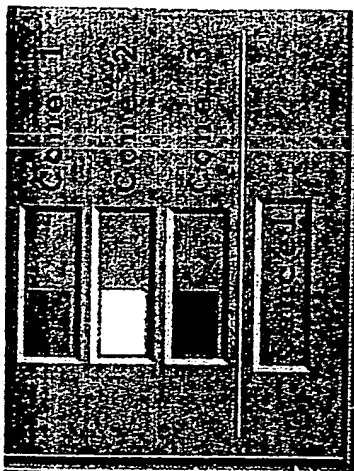
— R.O.P. = 25.47 m/hr (2.6 %  
higher)

— COVERAGE = 55.14 % (1.6 %  
lower)

## BRITTLE ROCK

R.O.P. = 24.45 m/hr (9.3 %  
lower)

COVERAGE = 36.70 % (7.3 %  
lower)



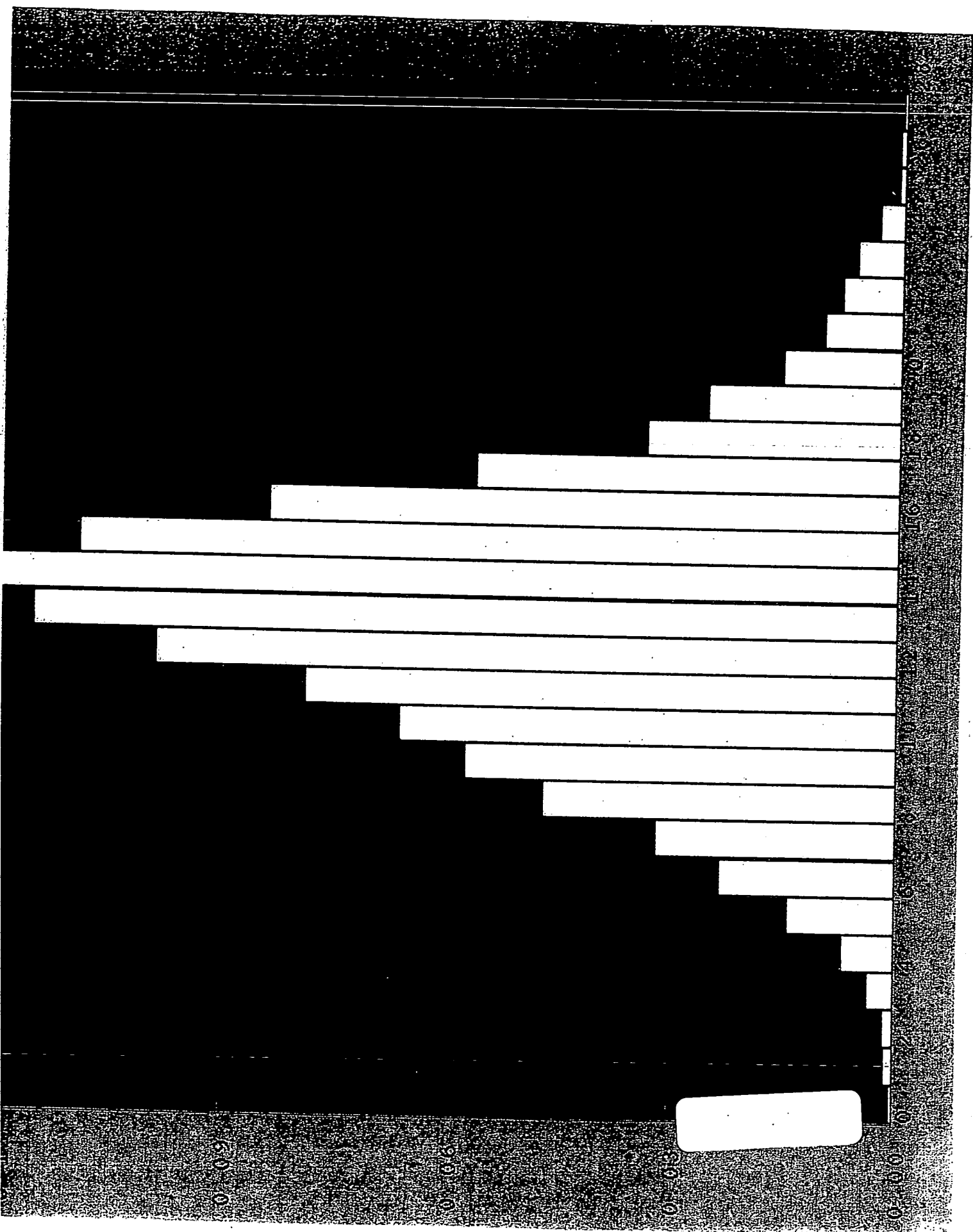
40%

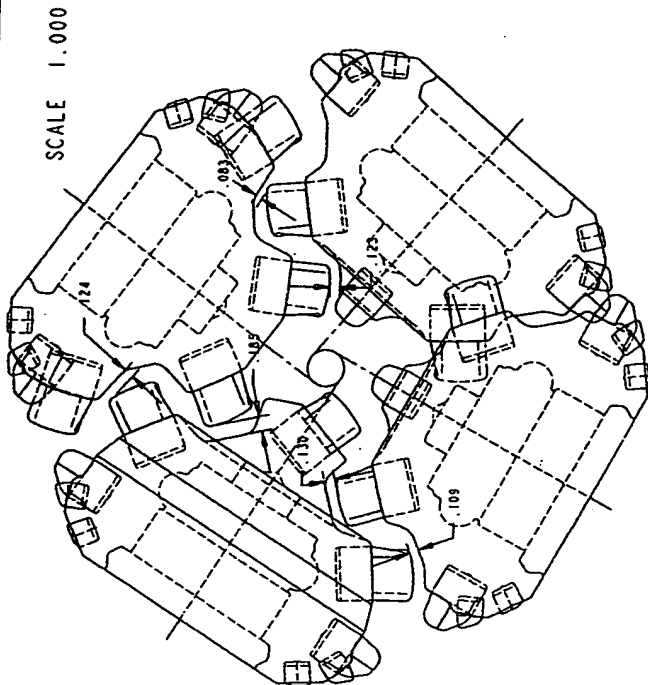
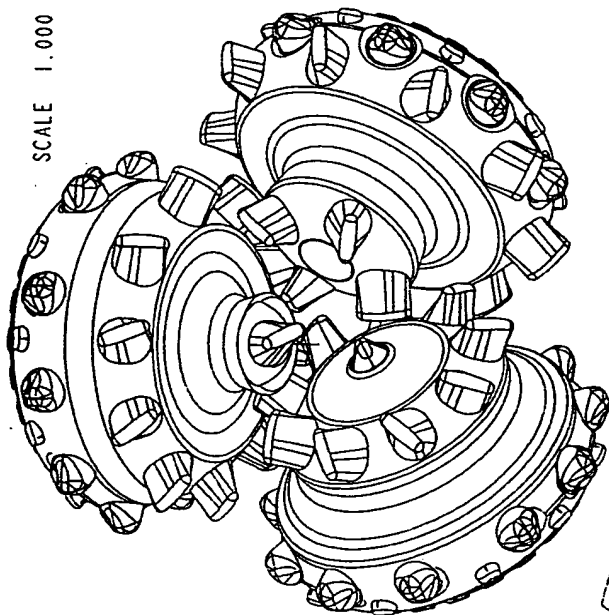
30%

20%

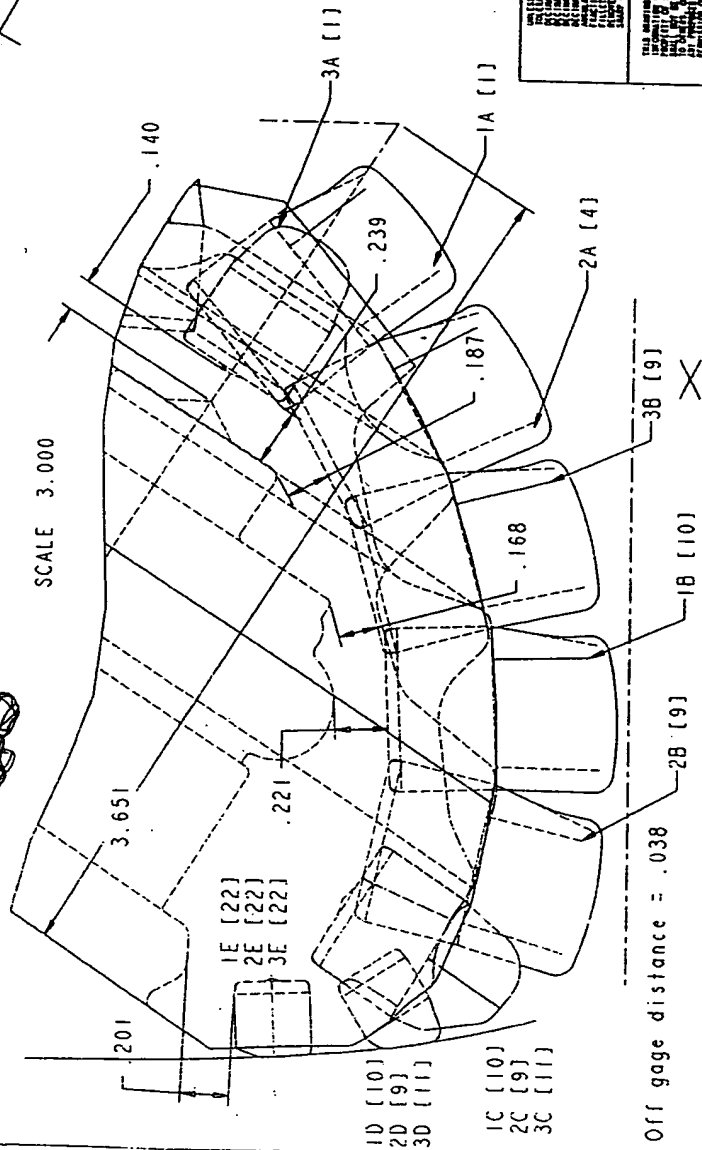
10%

0%





SCALE 3.000



Off gage distance = .038

NAME	ROW	INSERT	COUNT	PITCH	TYPE	DIAMID	LENGTH	EET	GRIP	GRADE
CONE1	A	ORCA1	10	10.42	ORCA	.3125	.875	.310	.250	814
	B	ORCA1	10	10.42	ORCA	.3125	.875	.310	.250	814
	C	R-GAGE	10	10.42	R-GAGE	.3125	.875	.310	.250	814
	D	0018134	10	10.42	31C	.3125	.875	.310	.250	814
CONE2	A	ORCA1	22	10.42	ORCA	.3125	.875	.310	.250	814
	B	ORCA1	22	10.42	ORCA	.3125	.875	.310	.250	814
	C	R-GAGE	22	10.42	R-GAGE	.3125	.875	.310	.250	814
	D	0018134	22	10.42	31C	.3125	.875	.310	.250	814
CONE3	A	0030323	4	10.42	ORCA	.3125	.875	.310	.250	814
	B	ORCA1	4	10.42	ORCA	.3125	.875	.310	.250	814
	C	R-GAGE	4	10.42	R-GAGE	.3125	.875	.310	.250	814
	D	0018134	4	10.42	31C	.3125	.875	.310	.250	814

PART NUMBER: LT077-ORCA

**SMITH TOOL**  
Division of Smith International Inc.

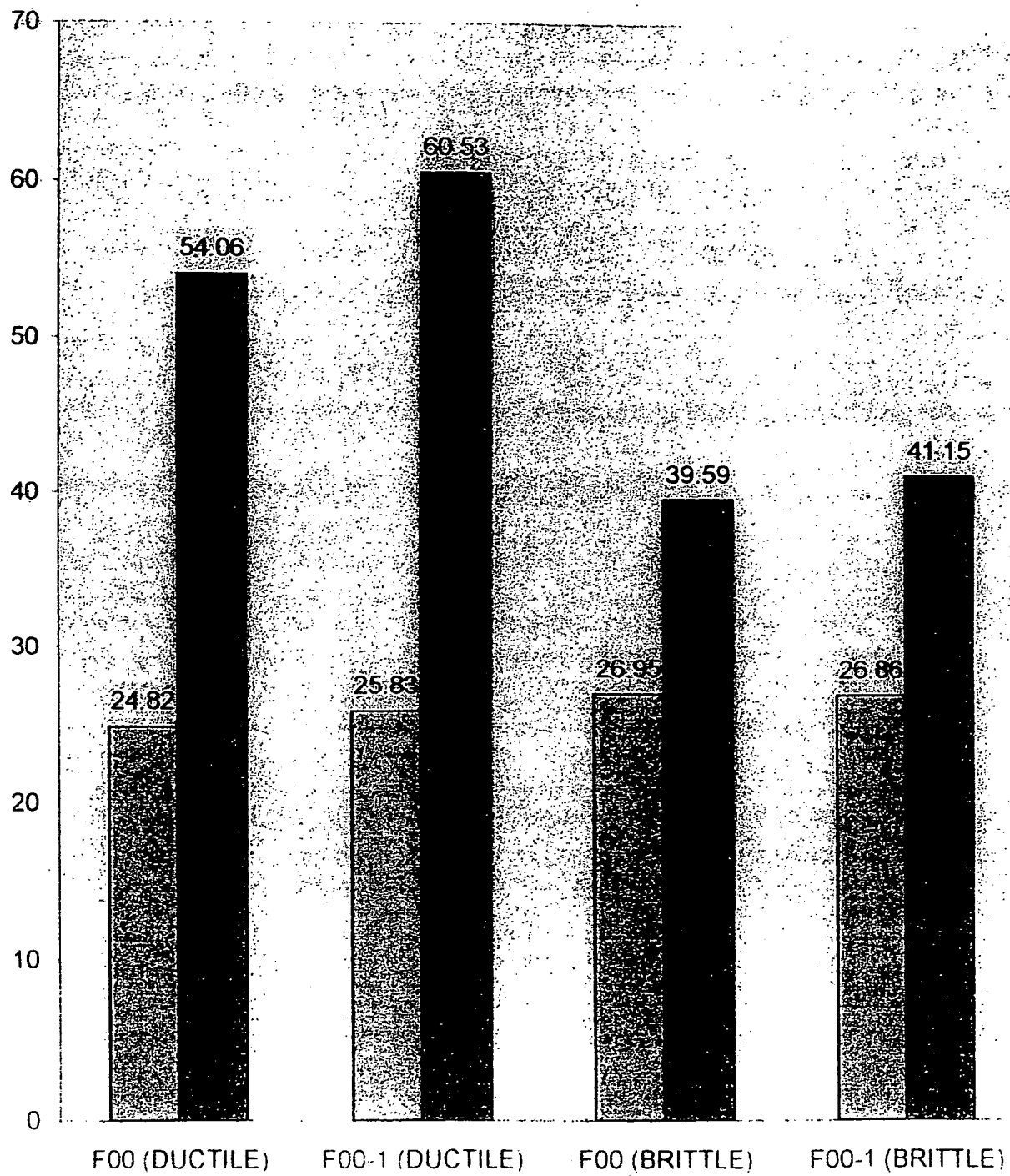
077 F00 BIT LAYOUT  
ORCA INSERTS

SIZE: 0.3 MODEL NAME: LT077-ORCA SHEET: 1 OF 1  
DATE: 4-Jun-98 DRAWING NO. REV  
C AS 4-Jun-98 DL7077-ORCA

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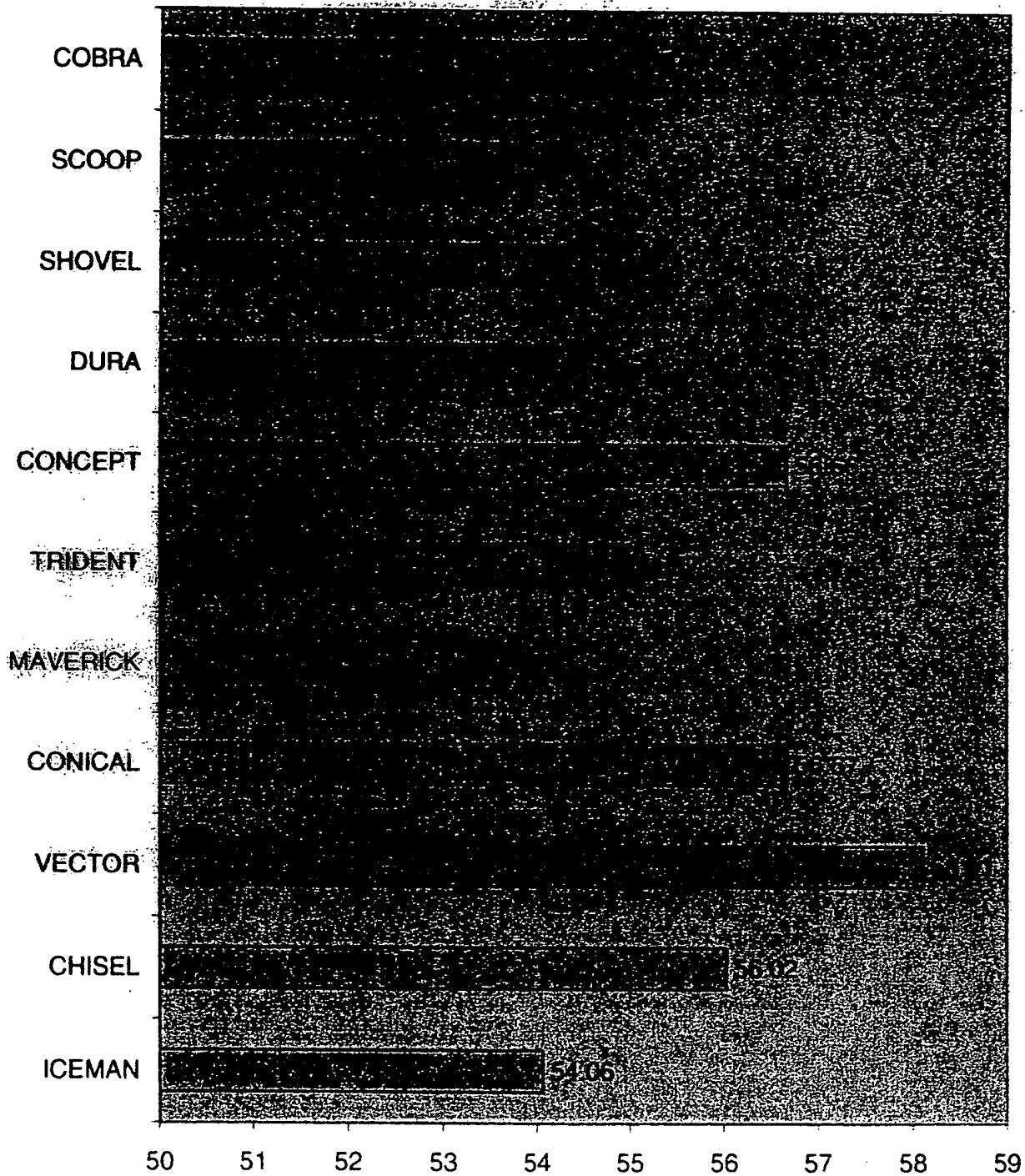
# COMPARISON OF CUTTING STRUCTURES

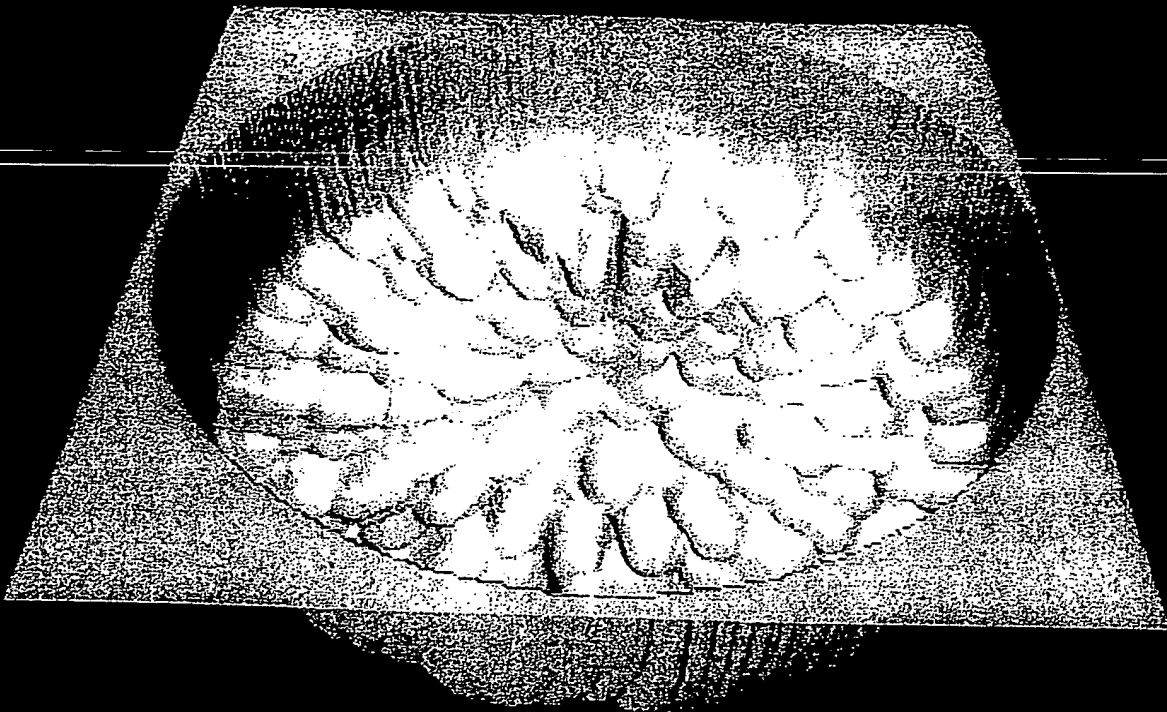
R.O.P. COVERAGE



# COMPARISON OF INSERT SHAPES IN DUCTILE ROCK

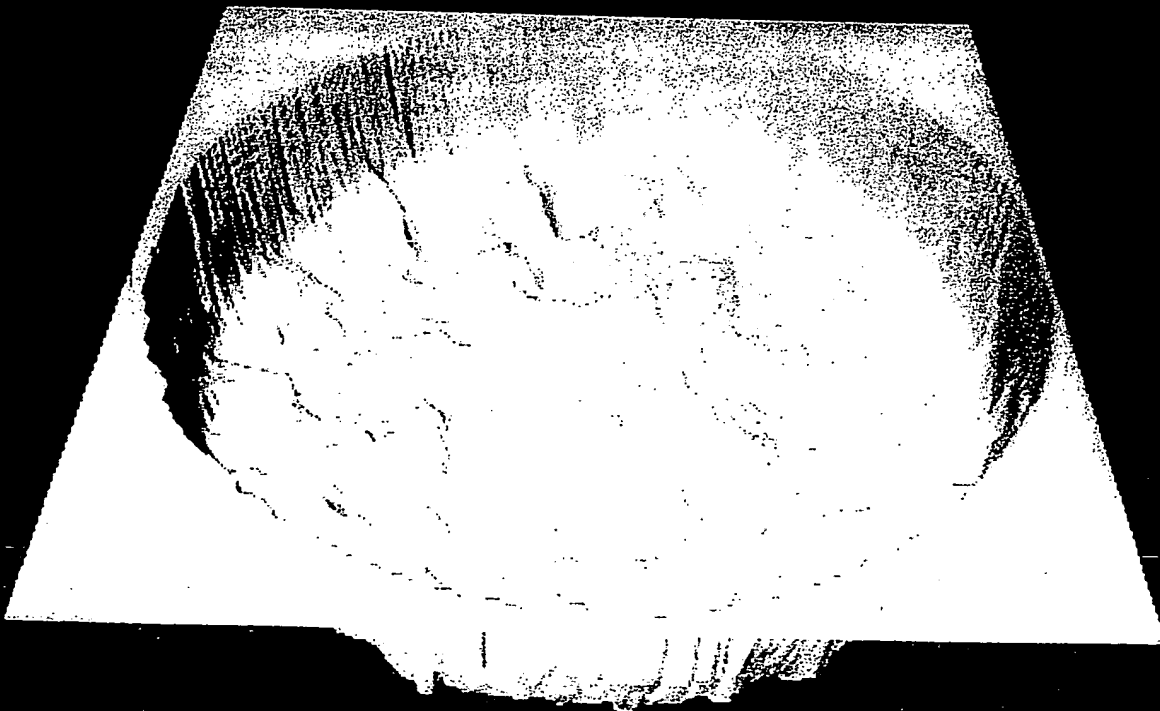
PERCENTAGE





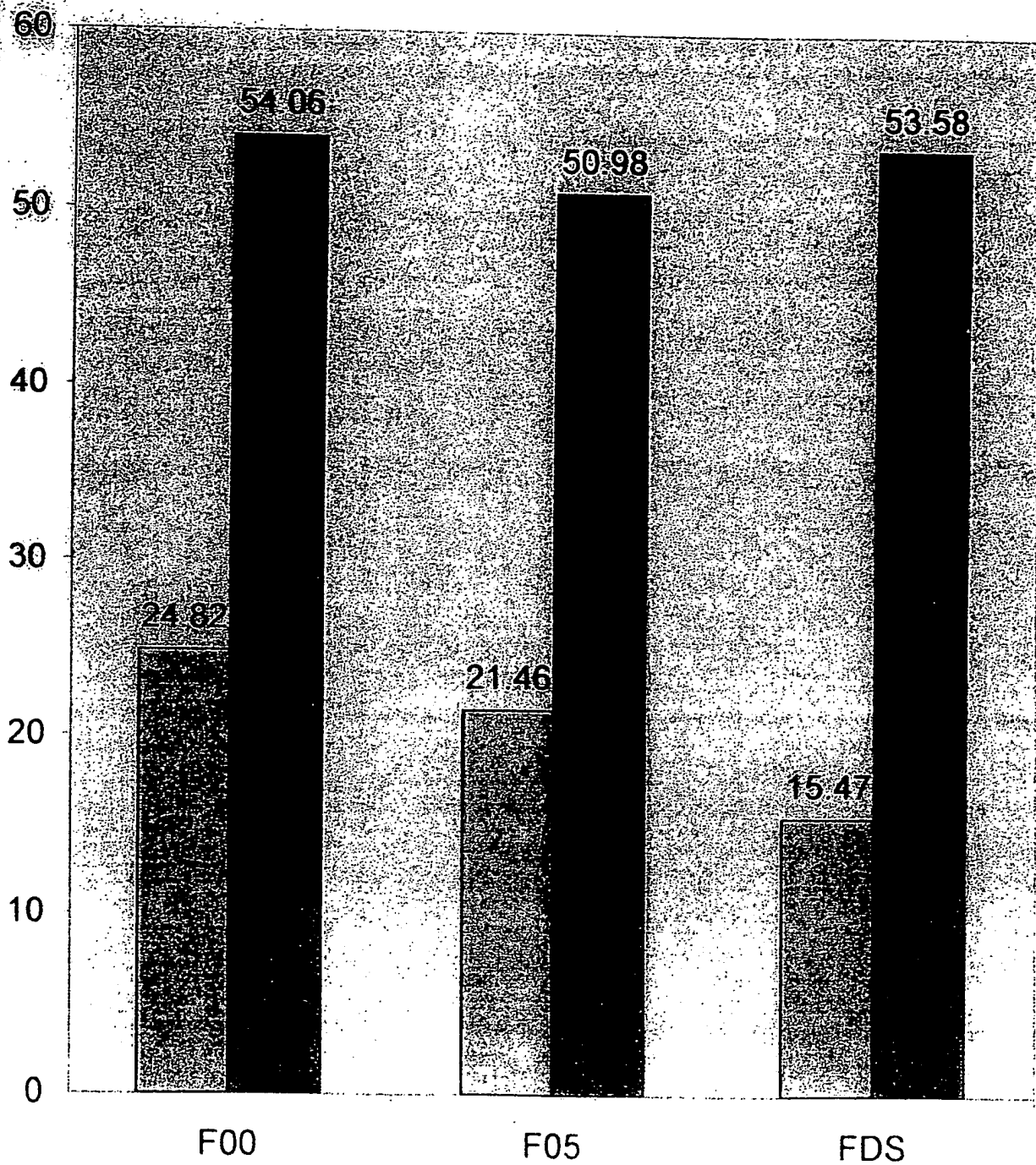
Rotx Roty

Dolly



# BENCHMARKING OF F00 BIT IN DUCTILE ROCK

■ R.O.P. ■ COVERAGE





# Achieving The Goal in Brittle Rock

## INSERT SHAPES

R.O.P. = 62% Increase  
[Vector] (Coverage being 5%  
lower)

COVERAGE = 5% Increase  
[Concept] (R.O.P. being 9%  
lower)

## ROW COUNTS

R.O.P. = 15% Increase [+1  
Insert on each row]

COVERAGE = 14% Increase  
[+2 Inserts on each row]

# Surpassing The Target In Ductile Rock

## INSERT SHAPES

R.O.P. = 12% Increase  
[Vector]

COVERAGE = 4% Increase  
[Vector]

## ROW COUNTS

R.O.P. = 16% Increase [-1  
Insert on each row]

COVERAGE = 5% Increase [-1  
Insert on each row]

# COMPARISON OF INSERT SHAPES IN BRITTLE ROCK

COBRA

DURA

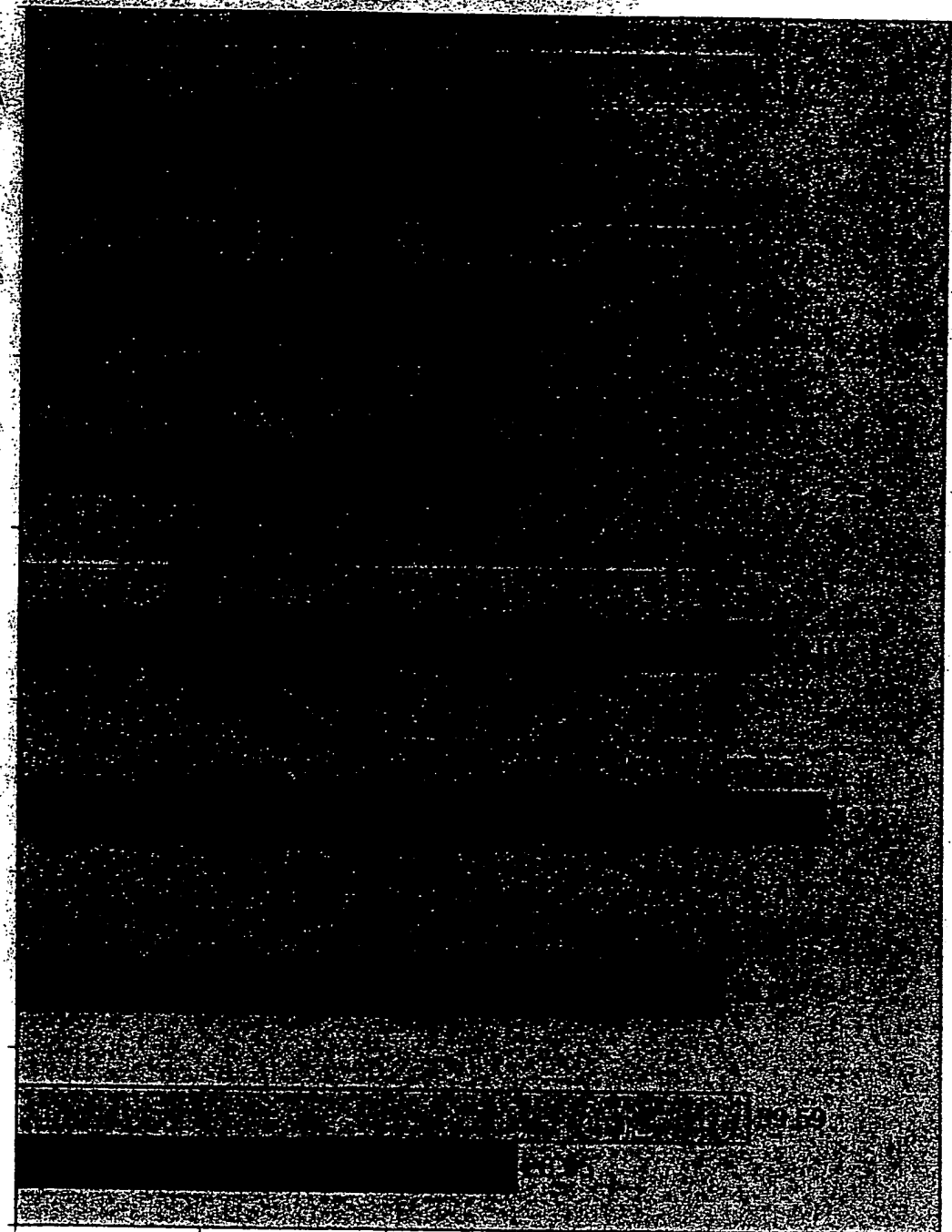
MAVERICK

CONICAL

VECTOR

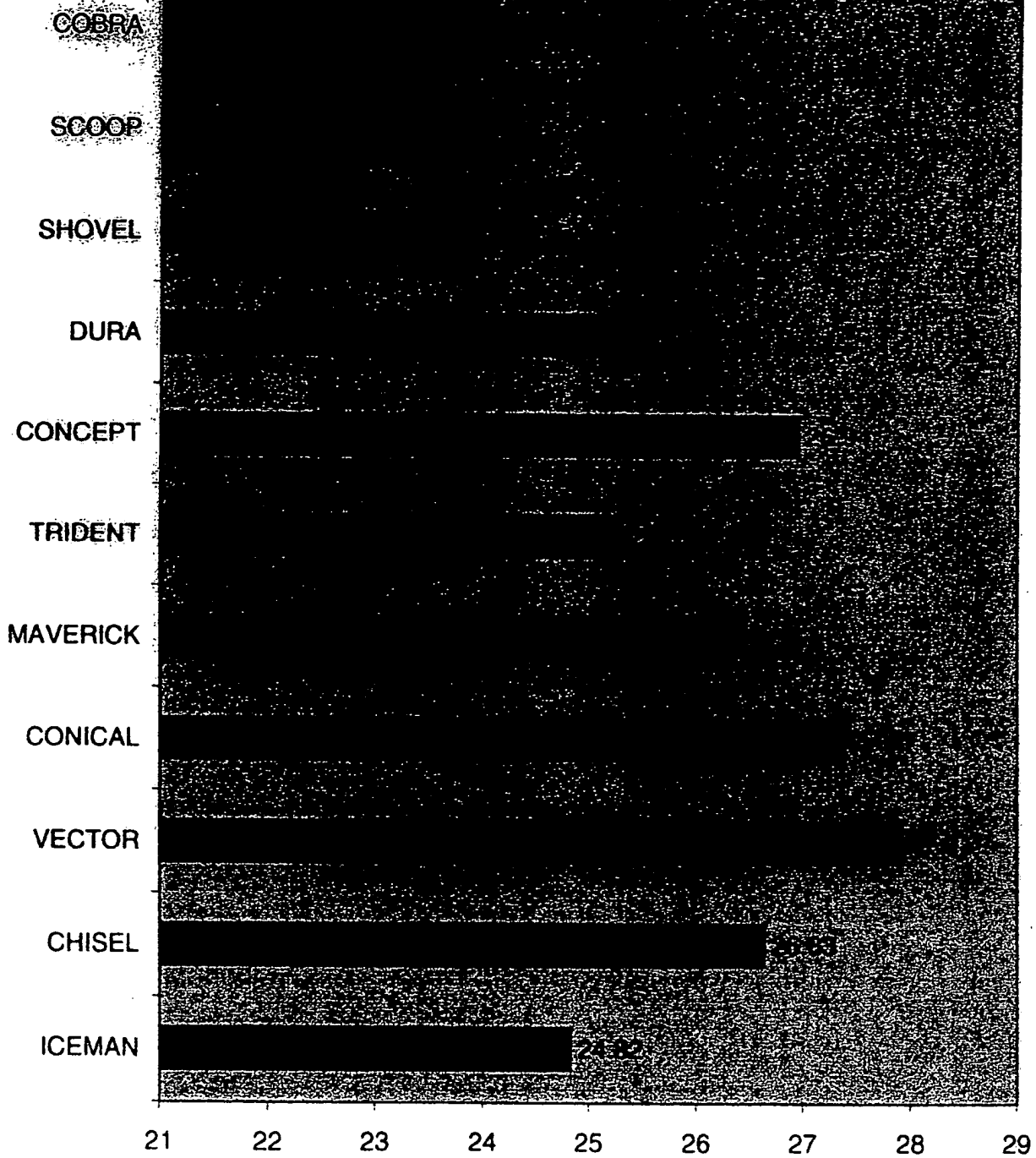
CHISEL

ICEMAN



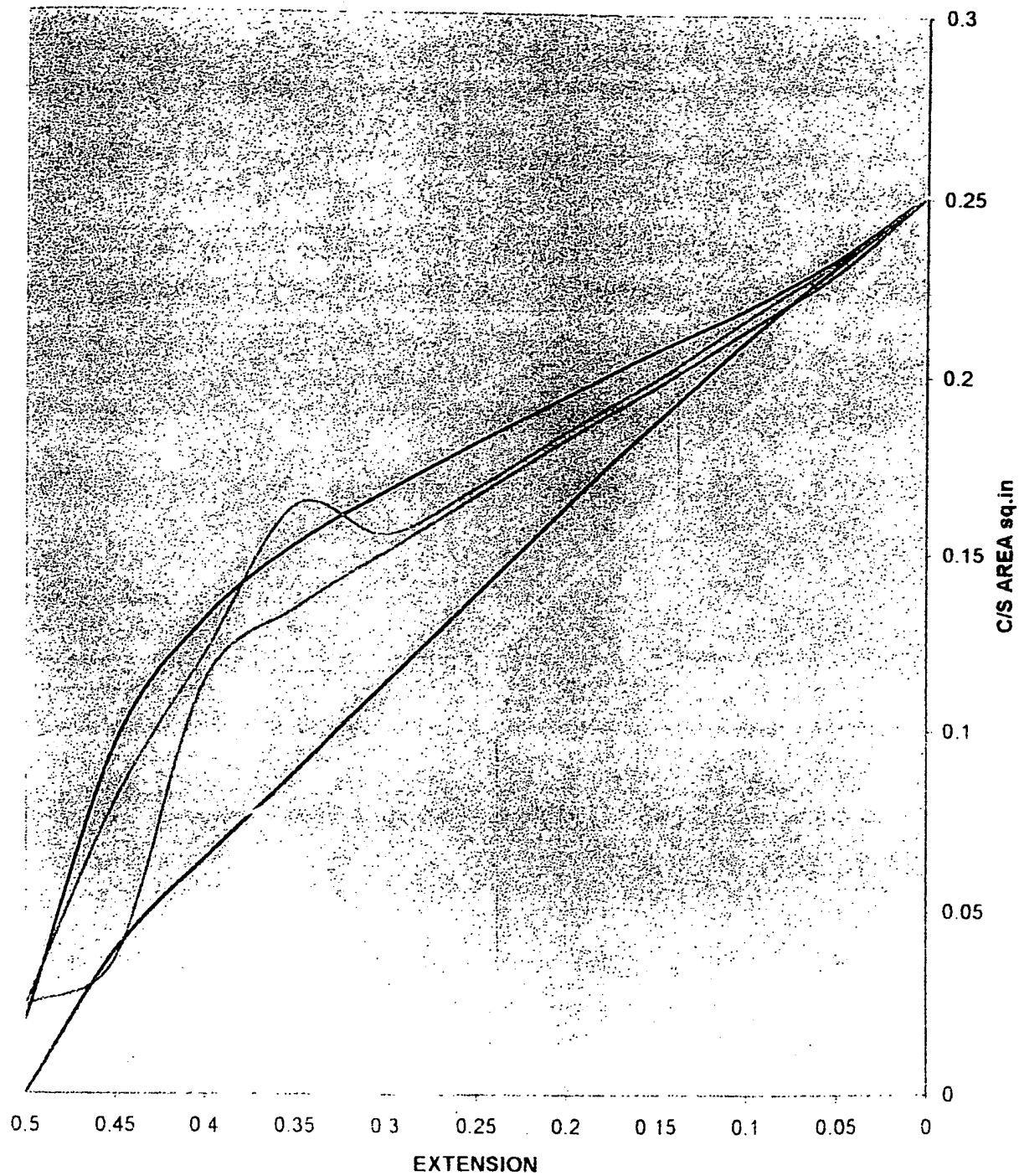
0 10 20 30 40 50

# COMPARISON OF INSERT SHAPES IN DUCTILE ROCK

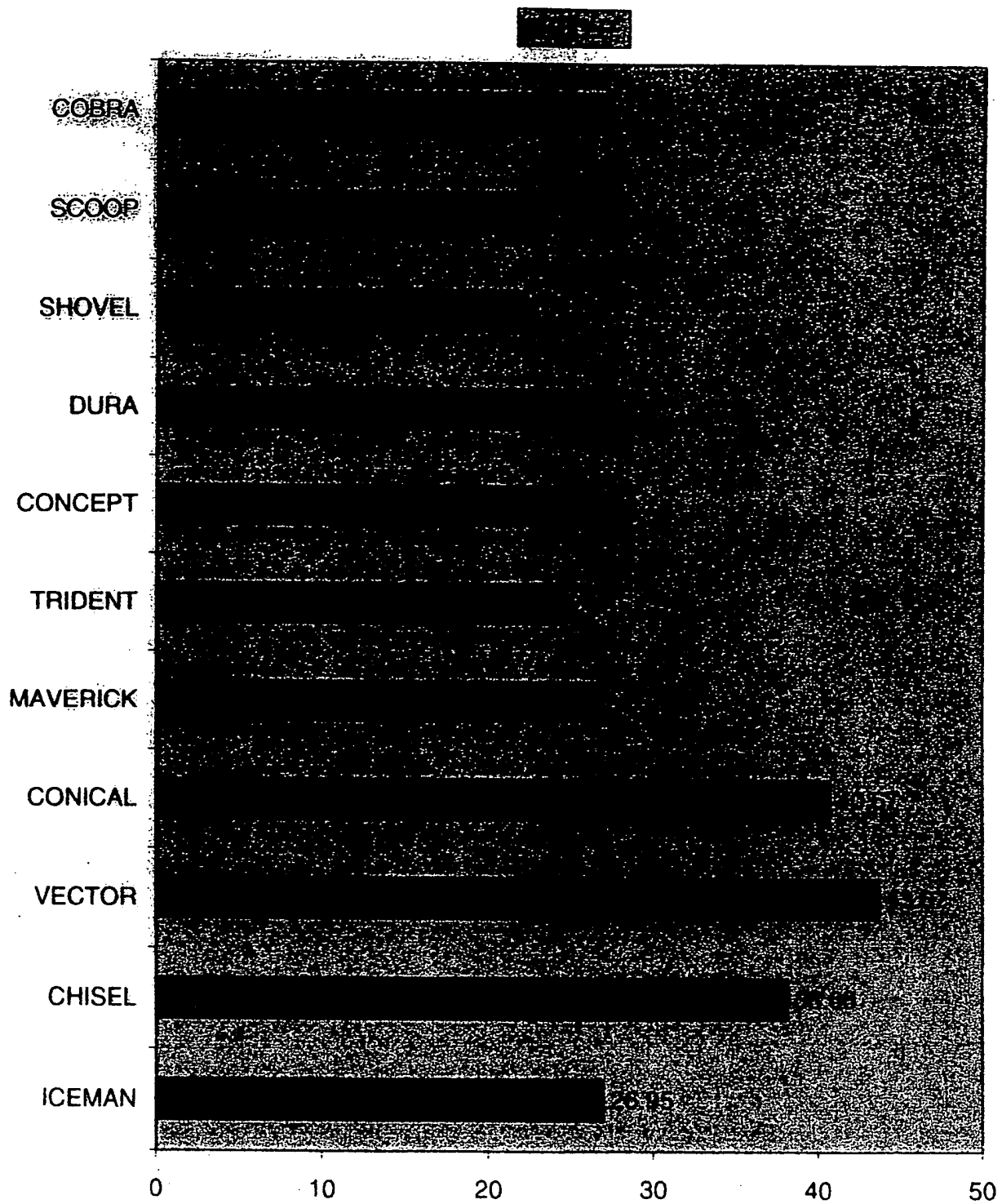


# CROSS-SECTION AREA FOR VARIOUS INSERTS

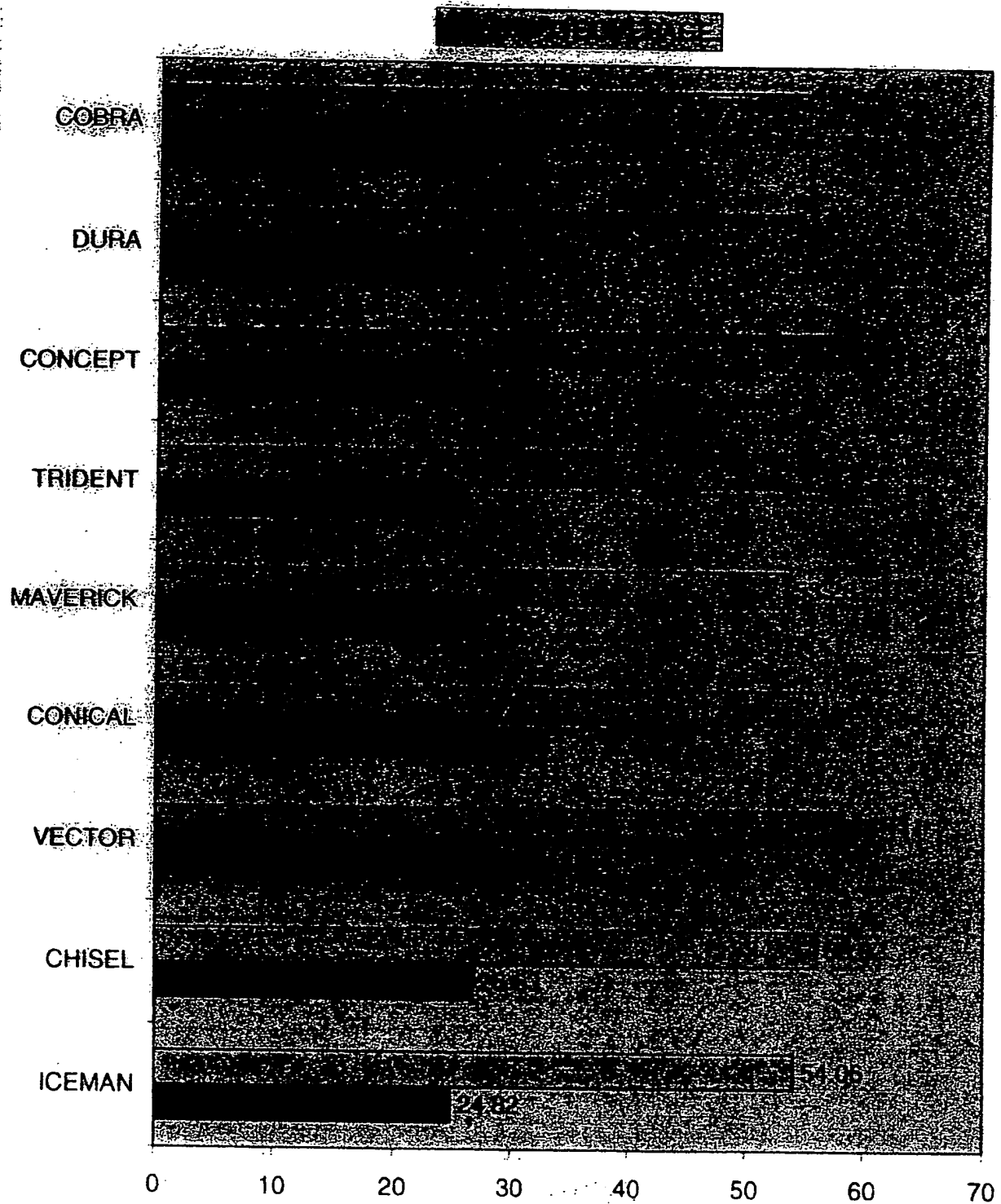
ICEMAN CHISEL VECTOR CONCEPT TRIDENT DURA



# COMPARISON OF INSERT SHAPES IN BRITTLE ROCK



# COMPARISON OF INSERT SHAPES IN DUCTILE ROCK



# Program validation and development

Duplicating field results

W.O.B. = 7-13 kdAN

R.P.M. = 80-240 rpm

R.O.P. = 35 m/hr

IDEAS Parameters & Results

Rock Types

Ductile

Brittle

W.O.B. = 10,000 kg-f

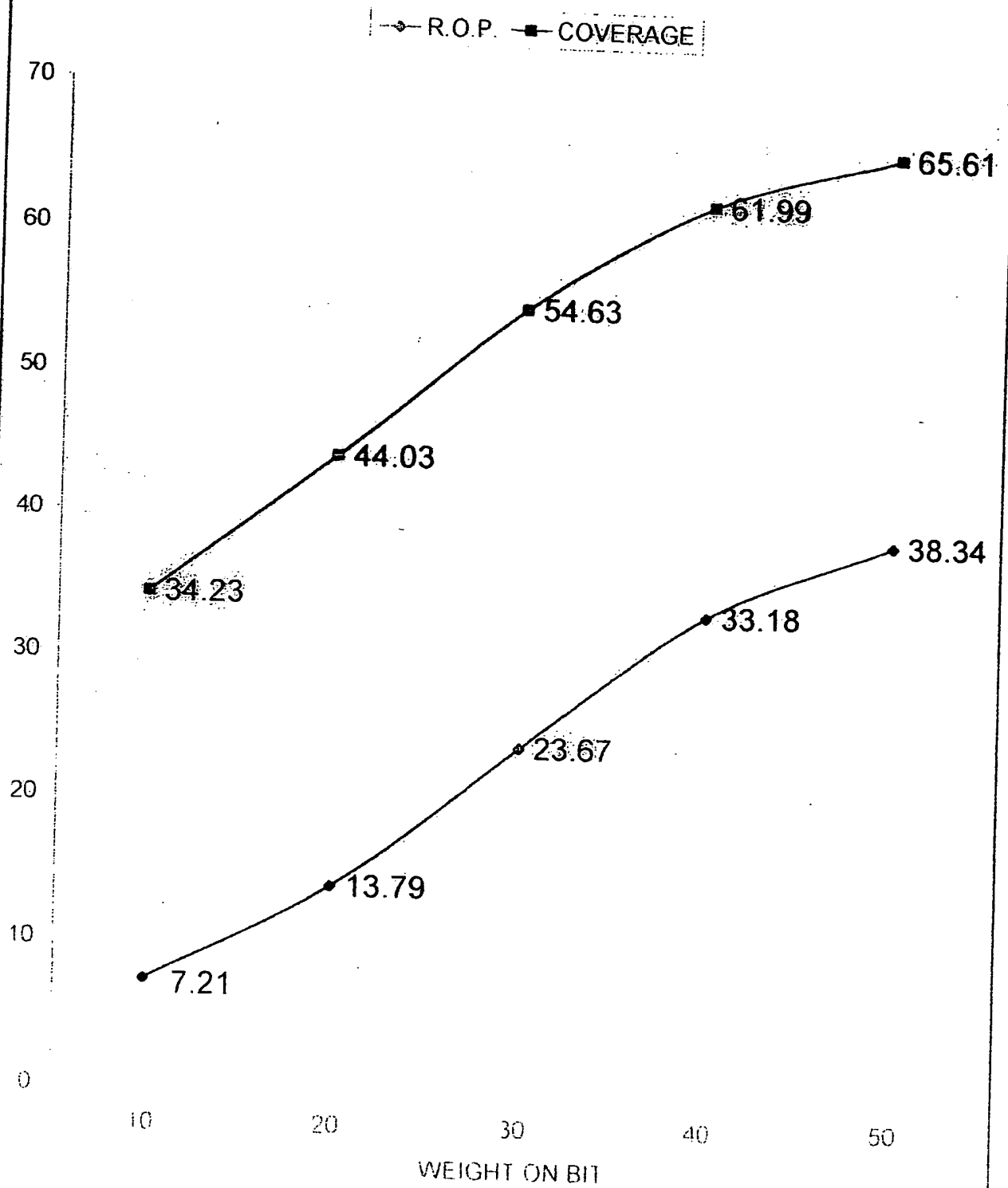
R.P.M. = 140 rpm

R.O.P. = 24-28 m/hr

■ Verifying performance trends

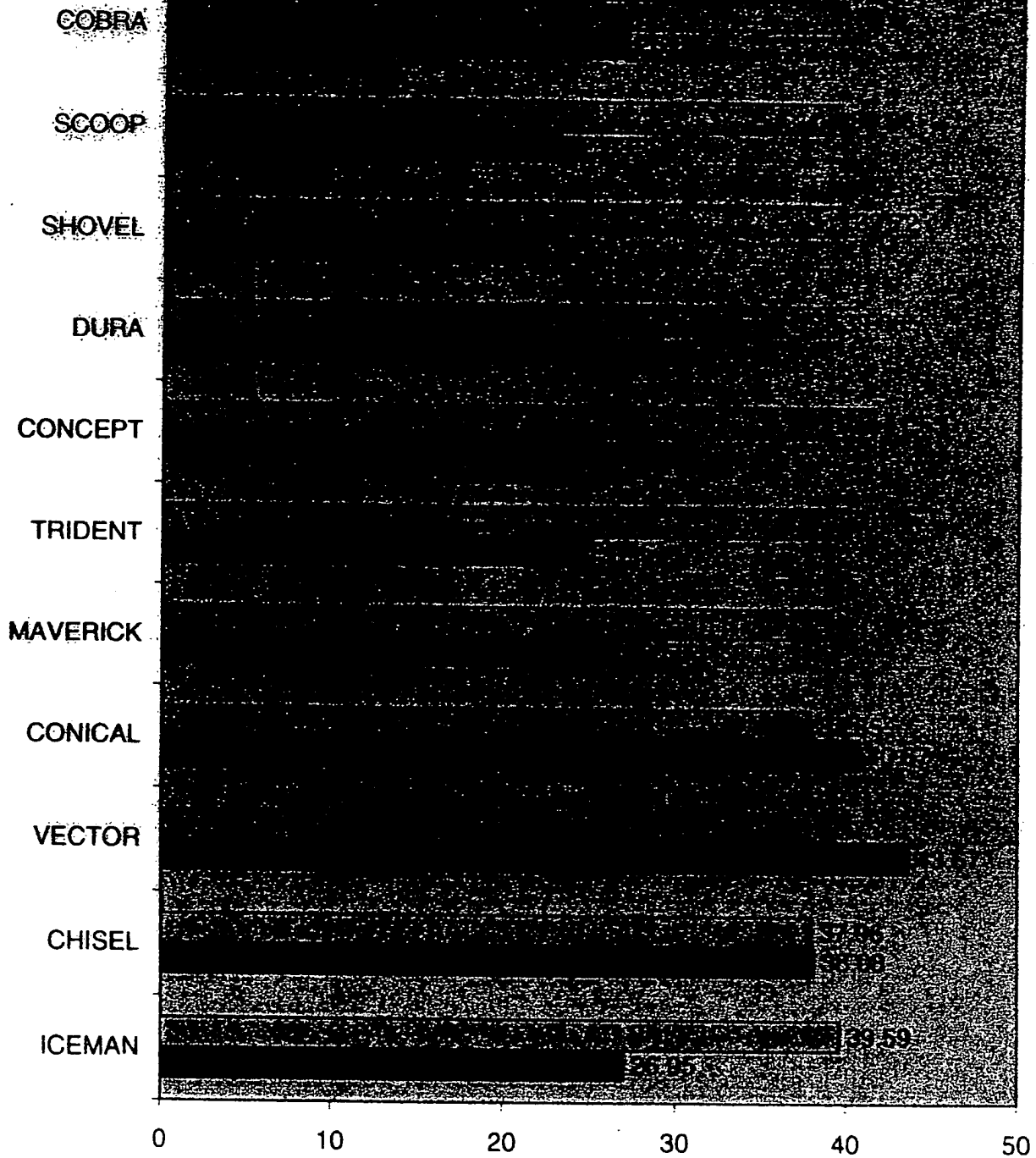


# PERFORMANCE OF F00 BIT IN MEDIUM DUCTILE ROCK

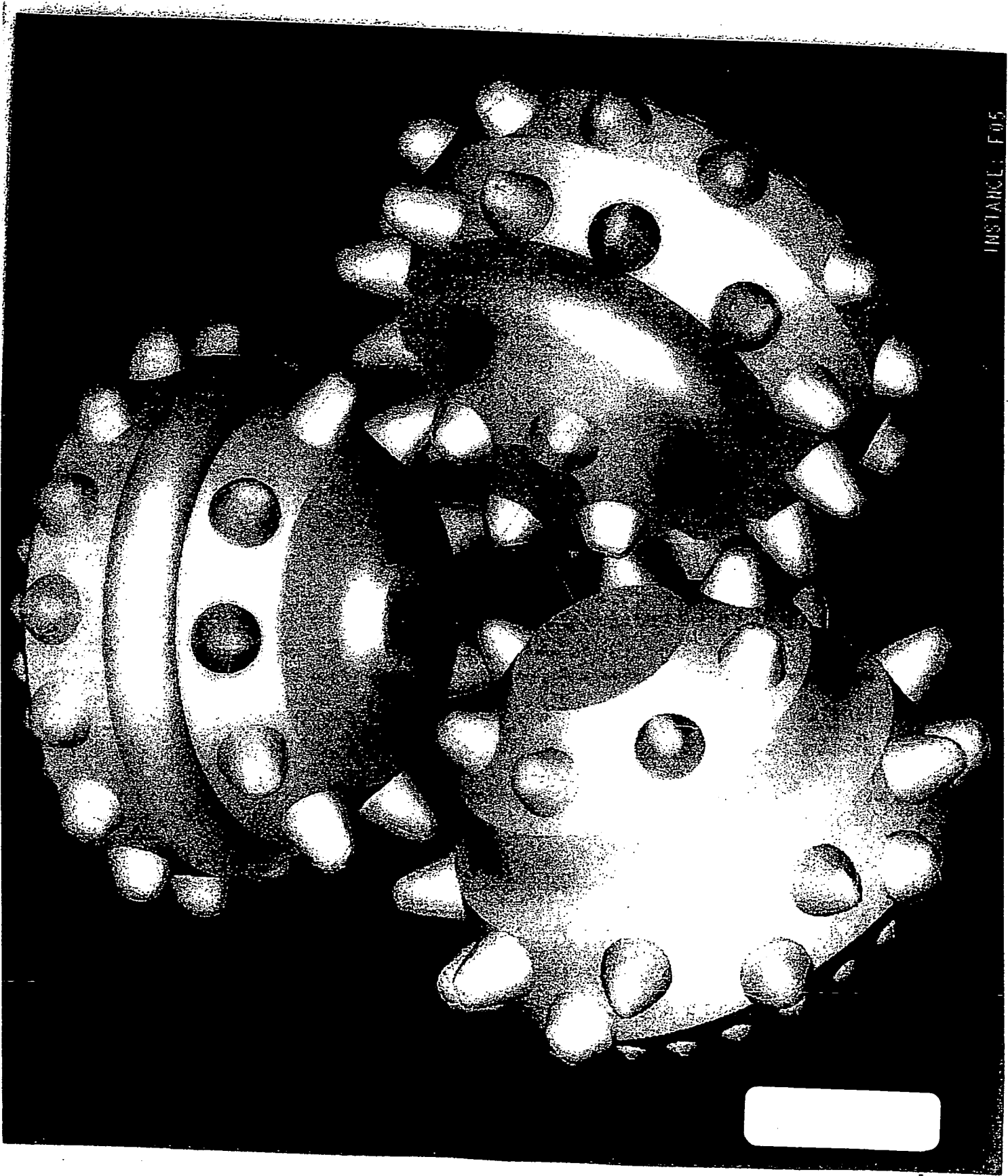


# COMPARISON OF INSERT SHAPES IN BRITTLE ROCK

INCHES



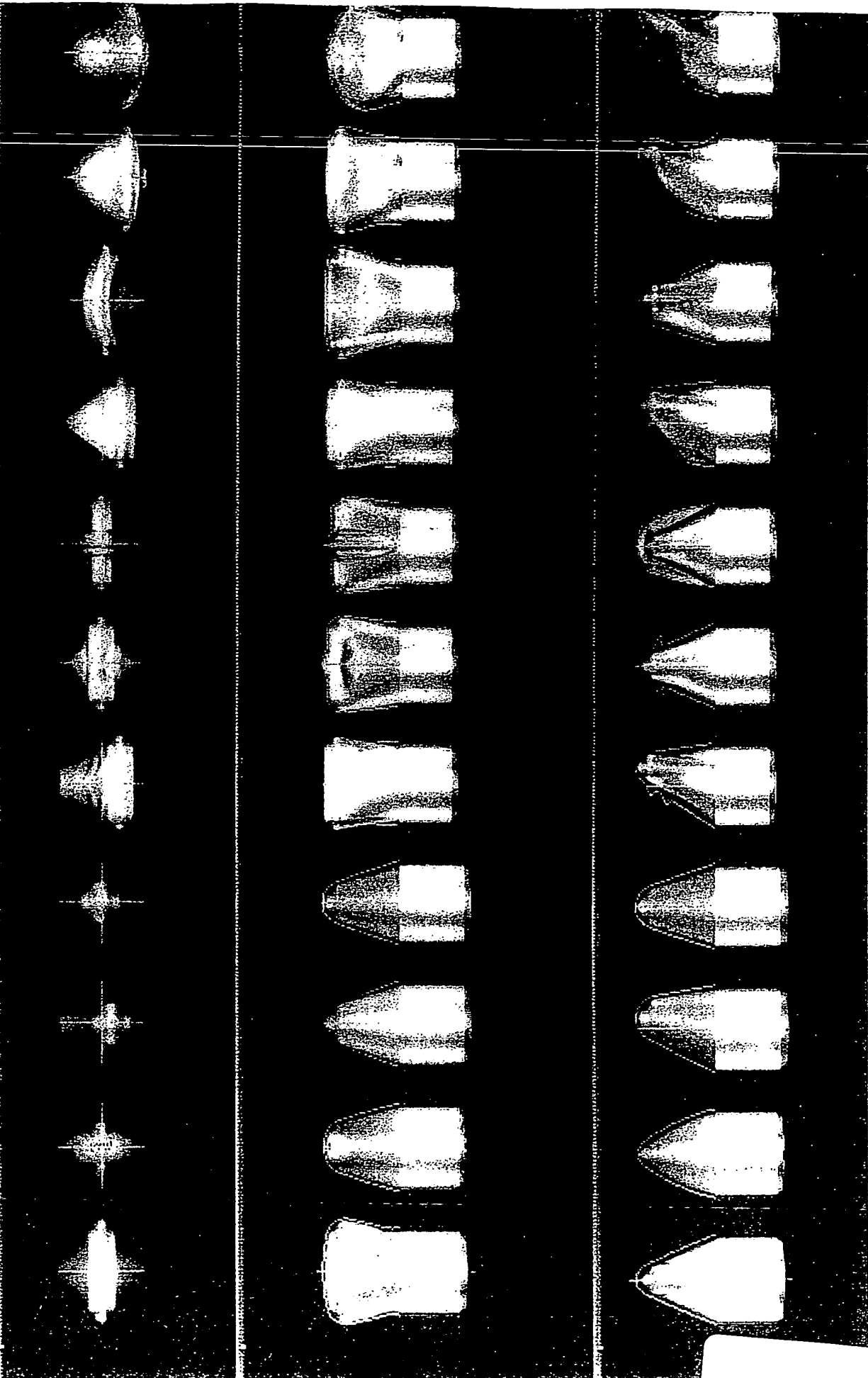
INSTARCE: F05

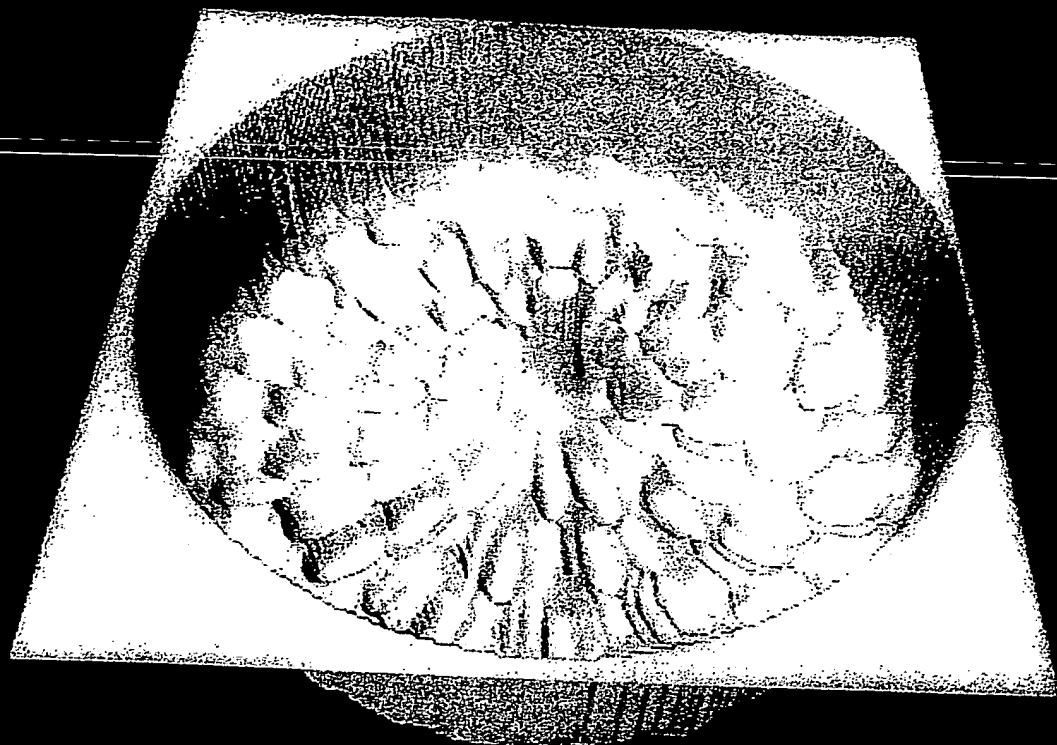


ICEMAN

CHITSEL VECTOR CONICAL VARIATION IN POSITION OF THE TIP

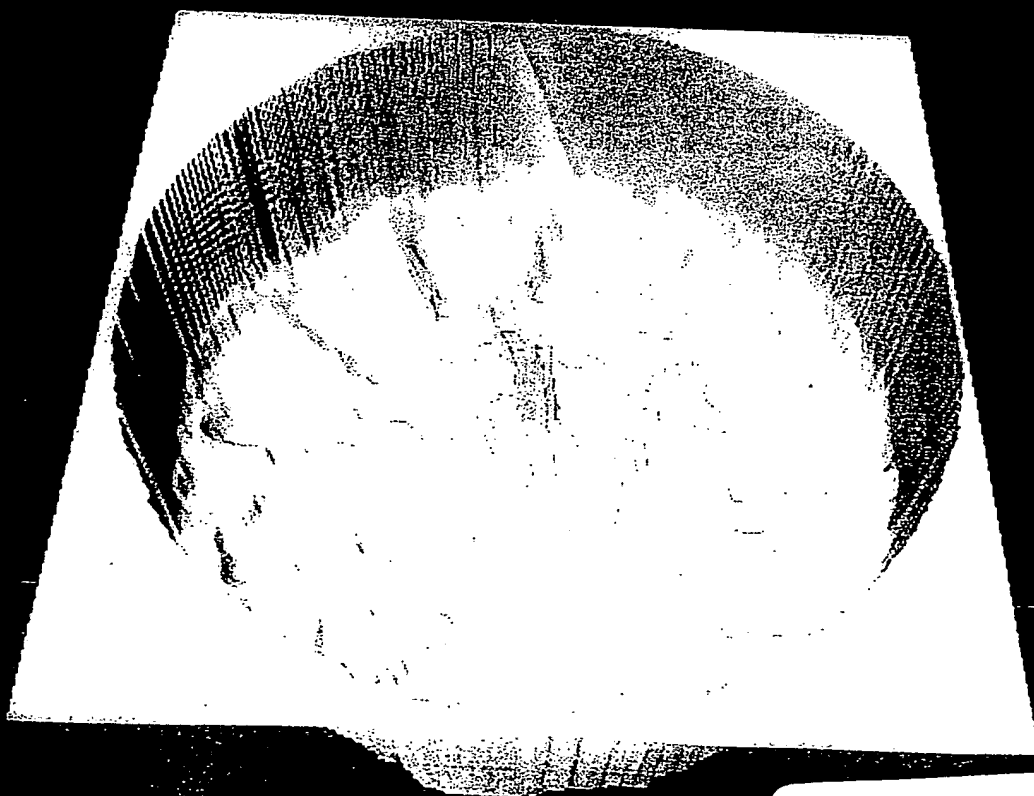
FIG. 1





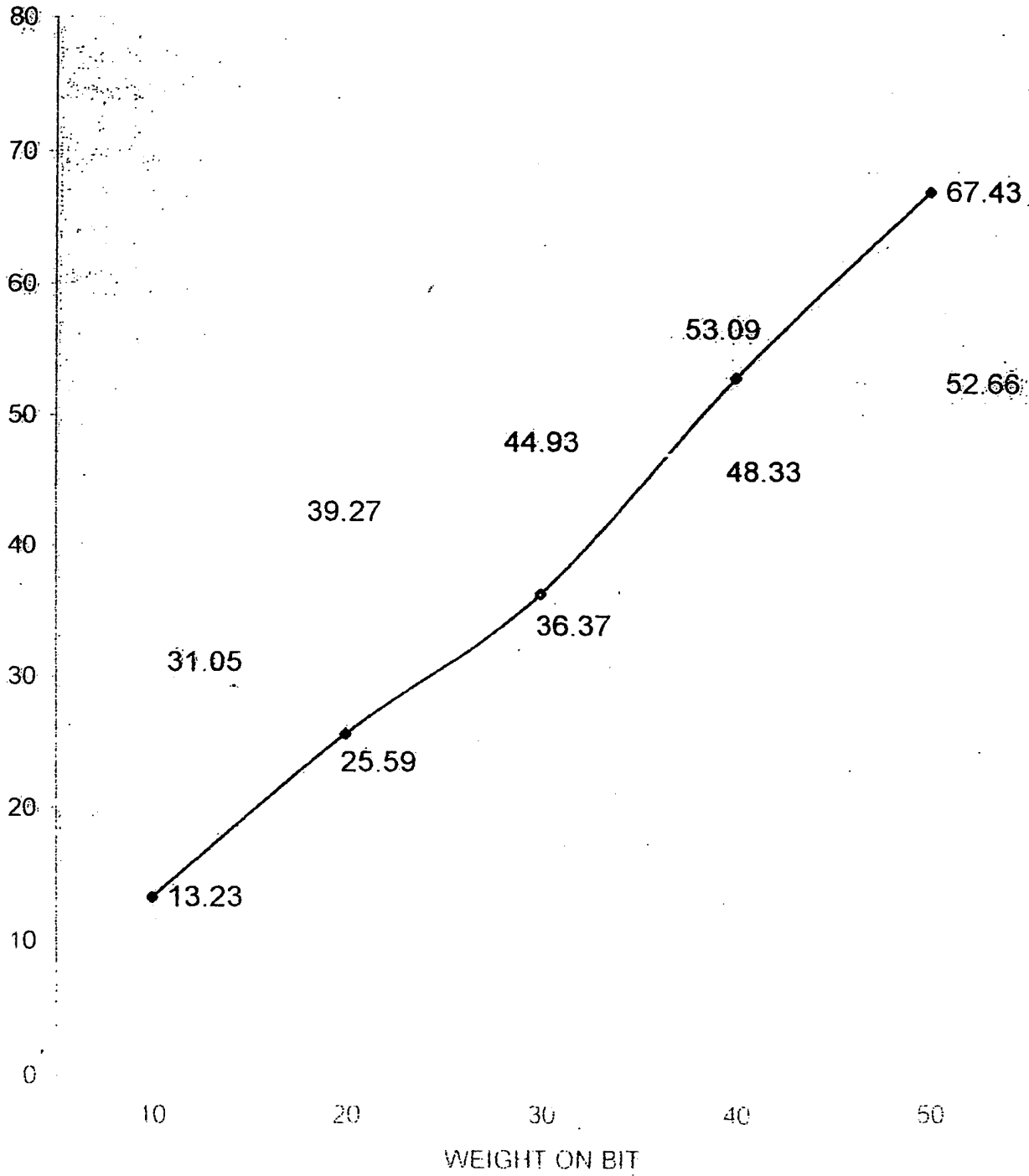
Rotx Roty

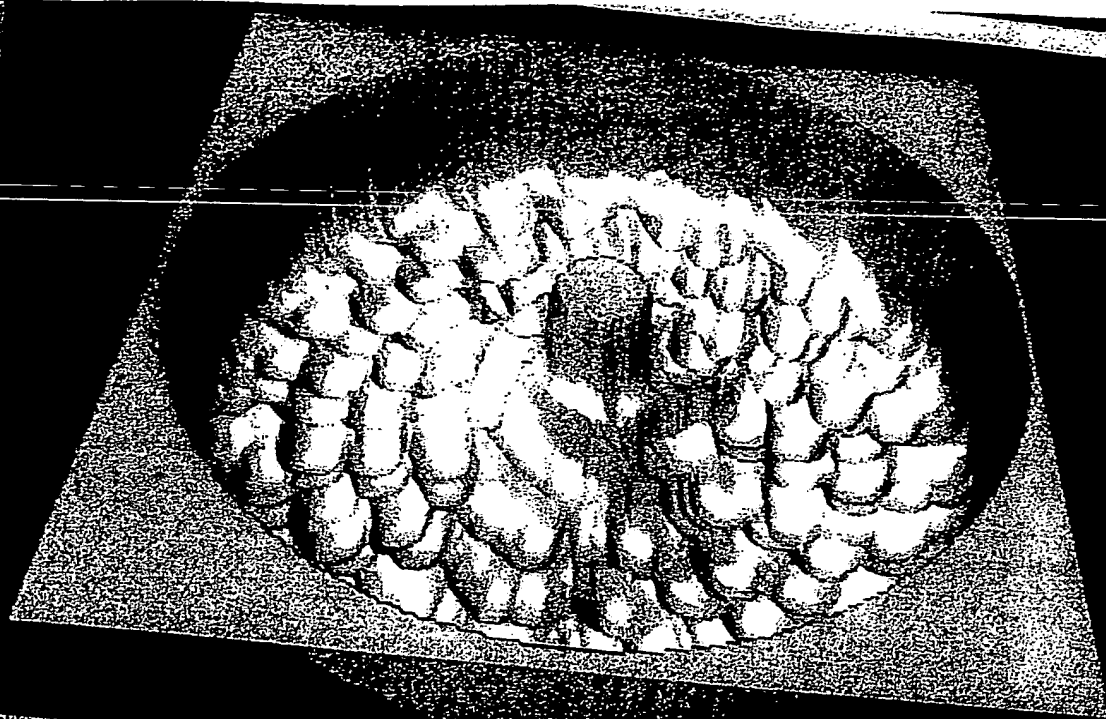
Dolly



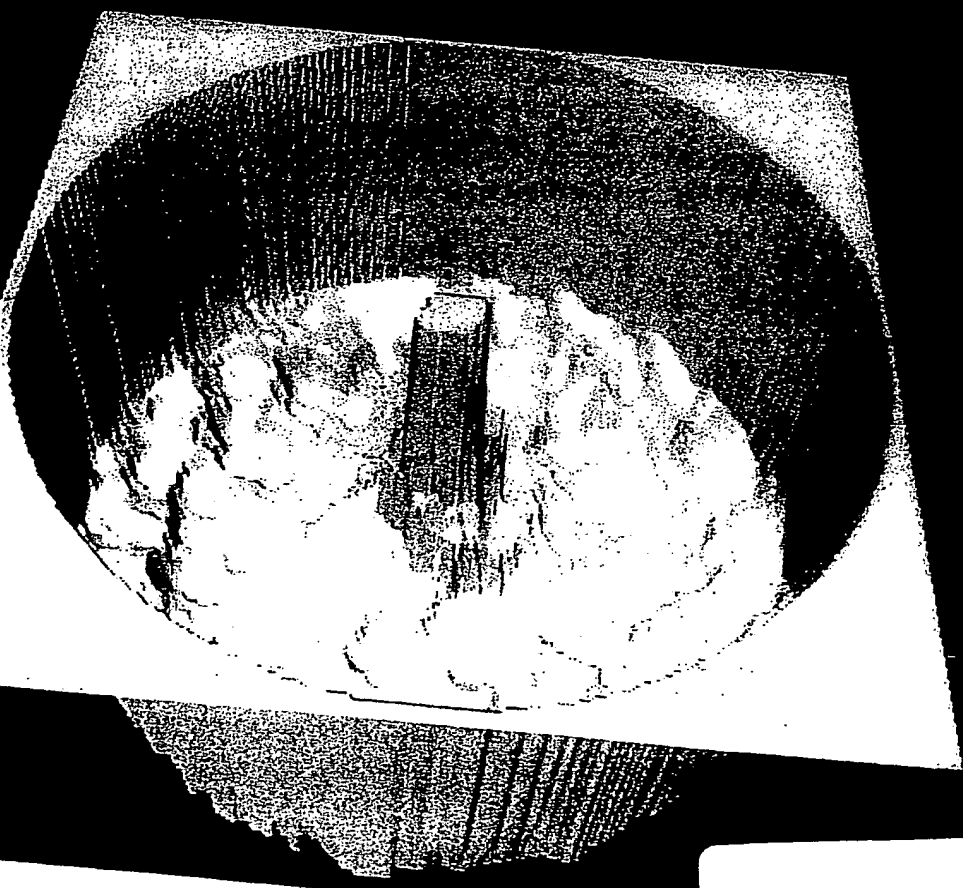
# PERFORMANCE OF F00 BIT IN BRITTLE ROCK

—●— R.O.P. COVERAGE



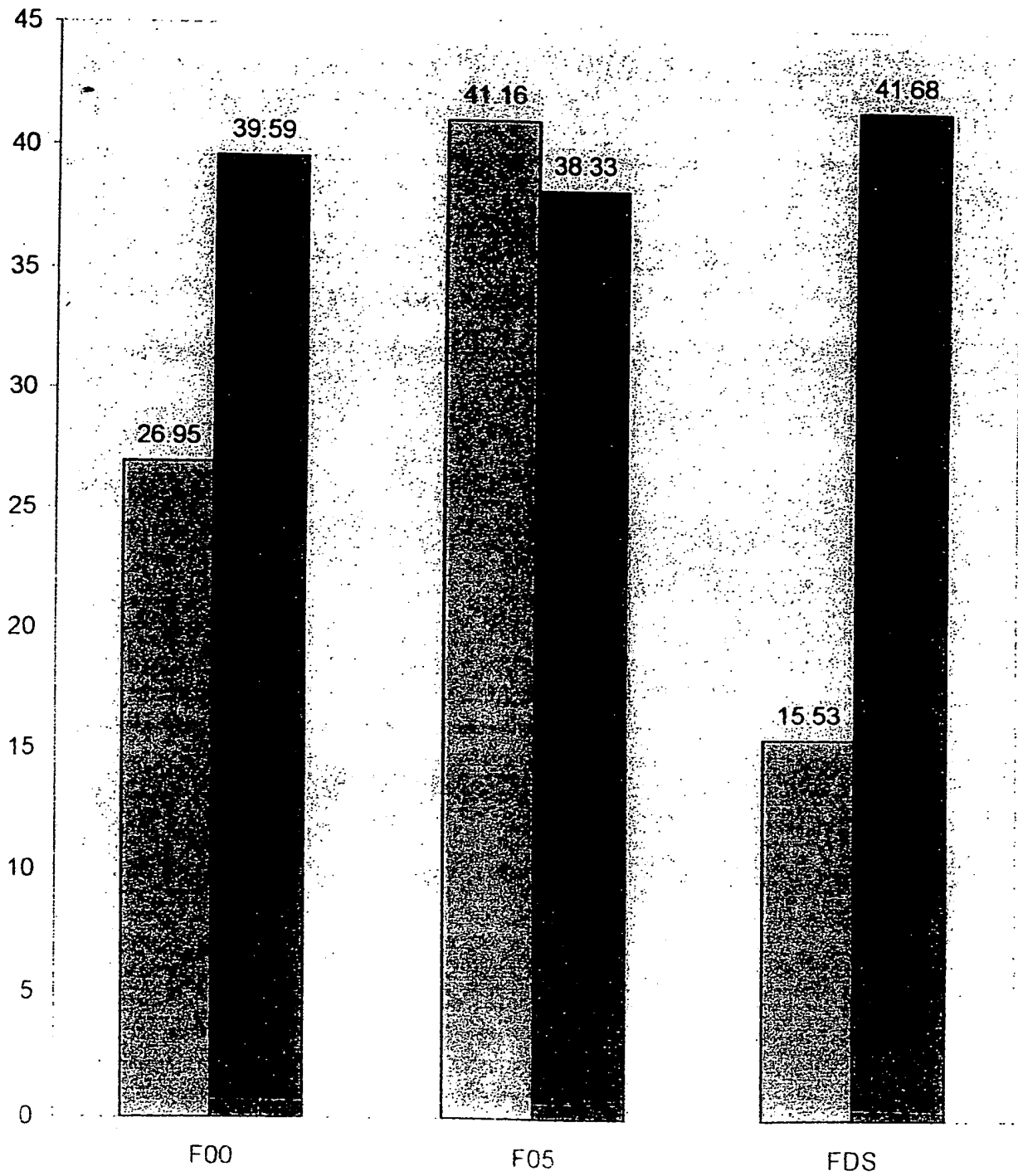


File Options Optimize



# BENCHMARKING OF F00 BIT IN BRITTLE ROCK

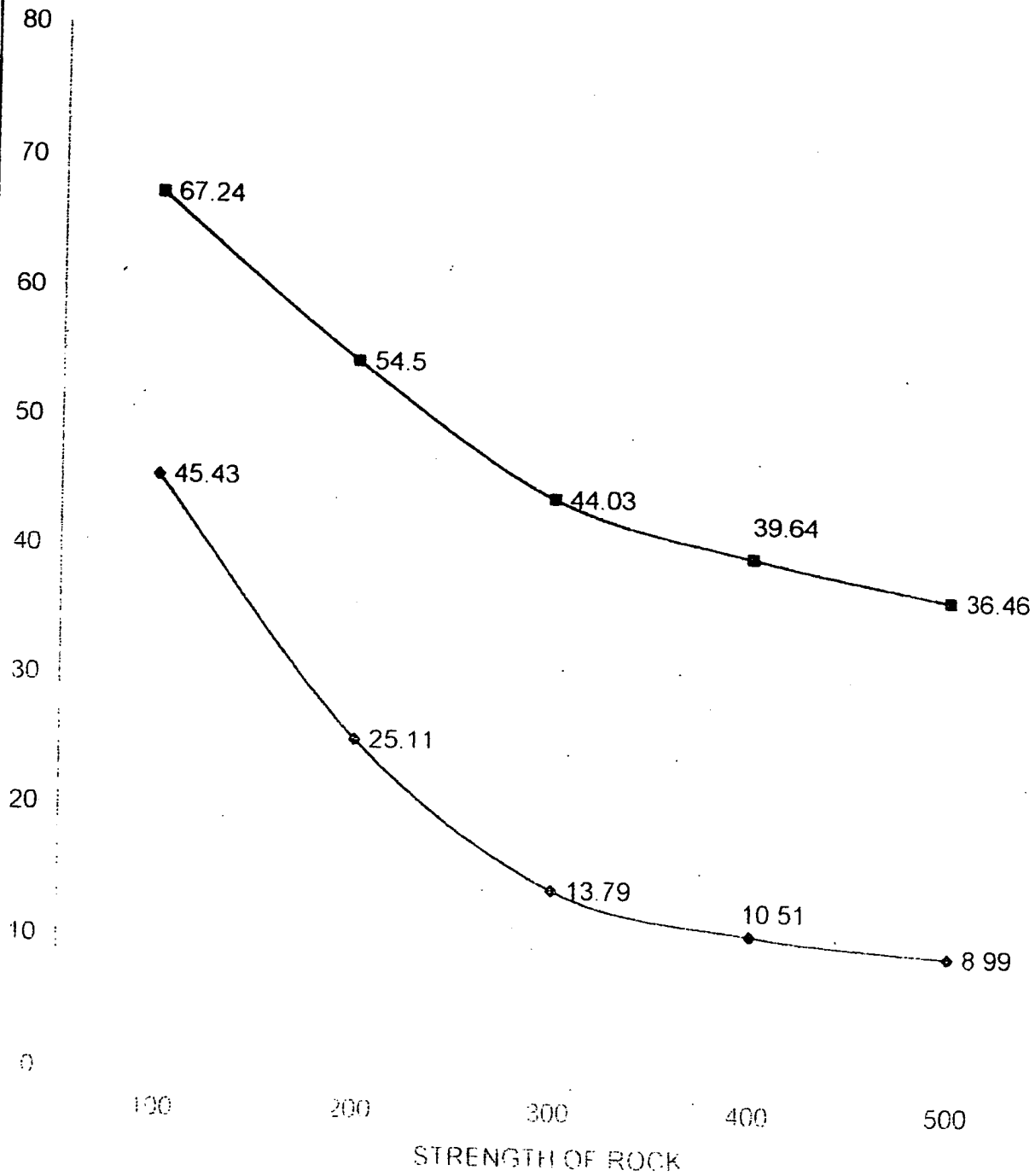
R.O.P. COVERAGE





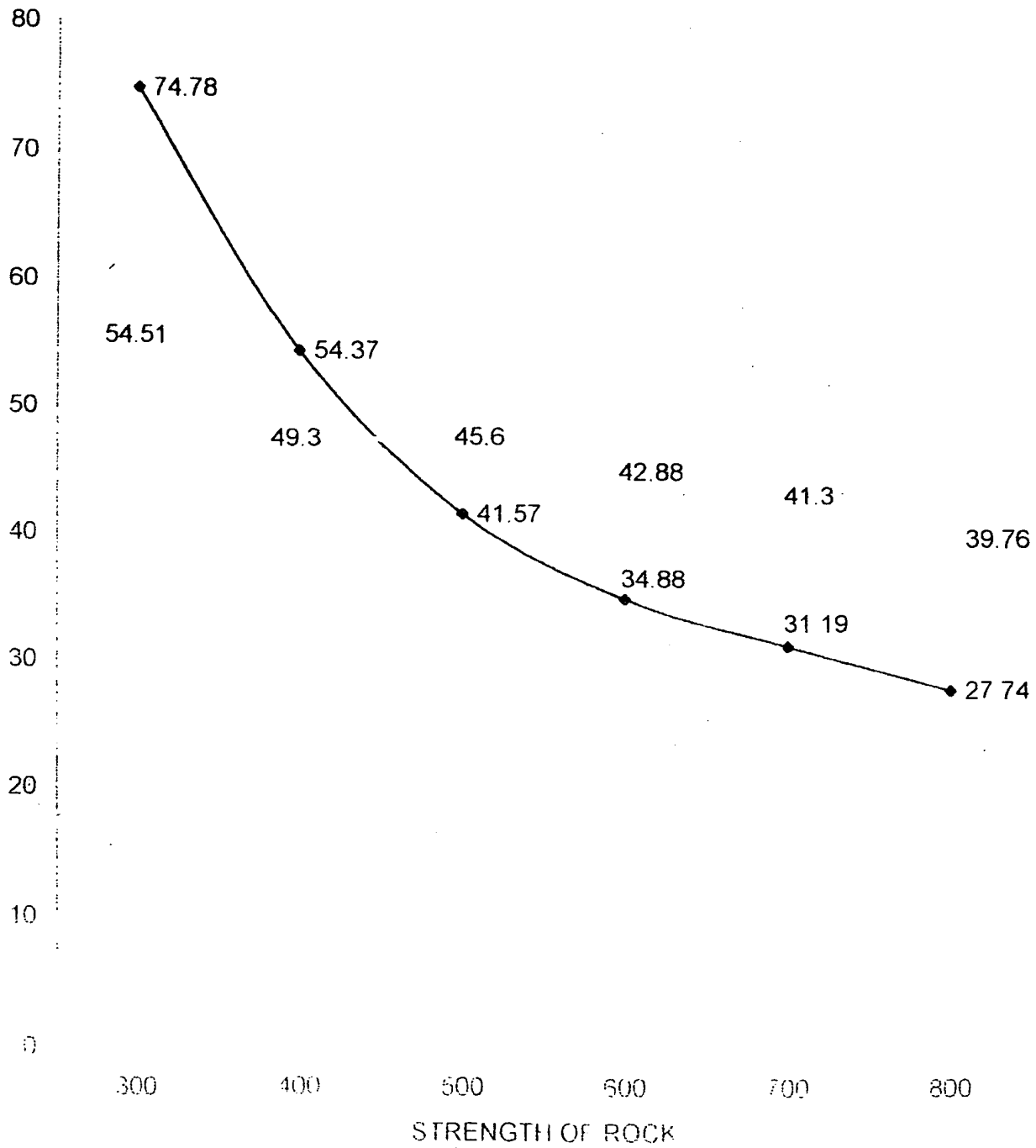
# PERFORMANCE OF F00 BIT IN DUCTILE ROCK OF INCREASING STRENGTH

—◆— R.O.P. —■— COVERAGE

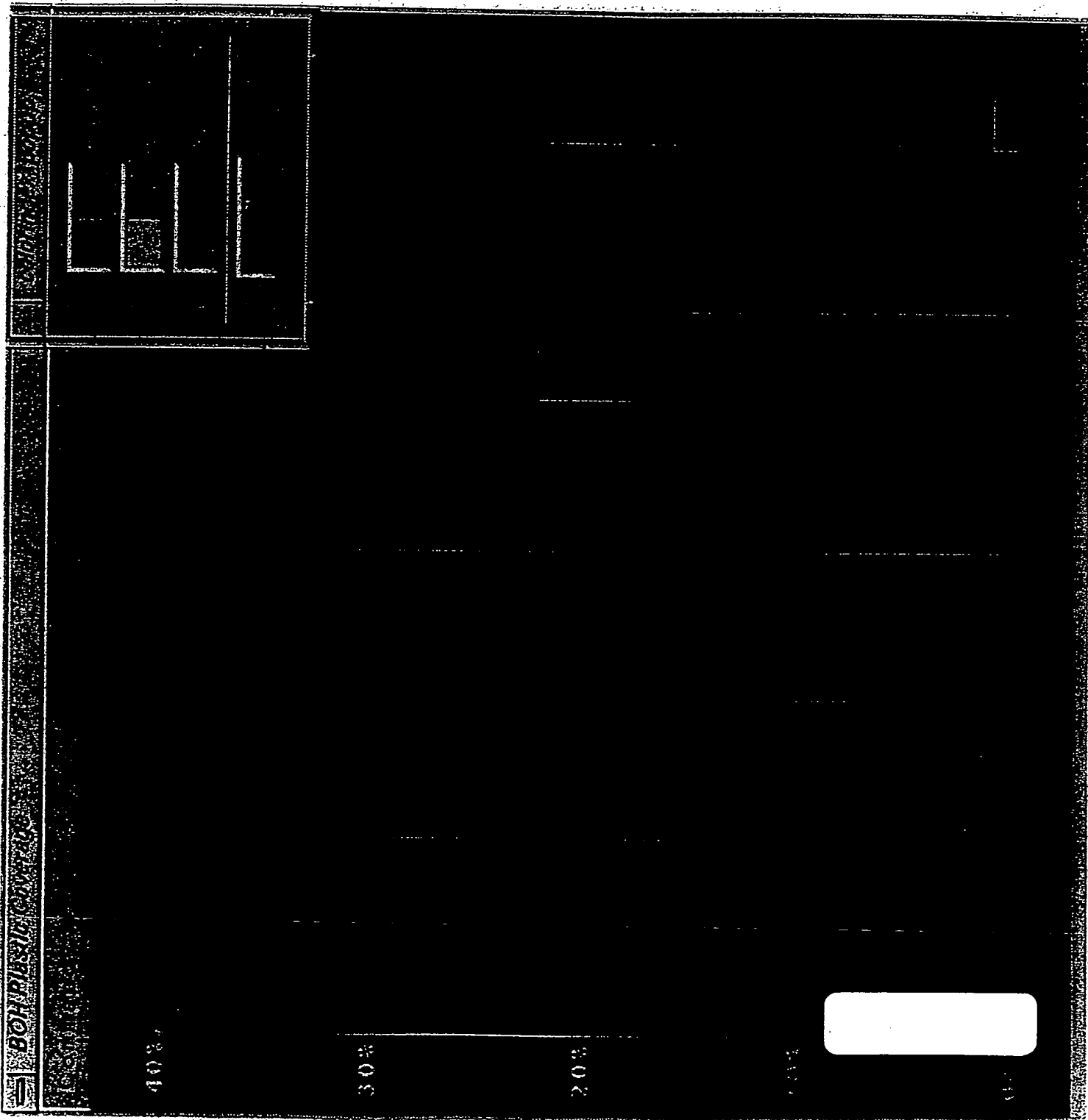


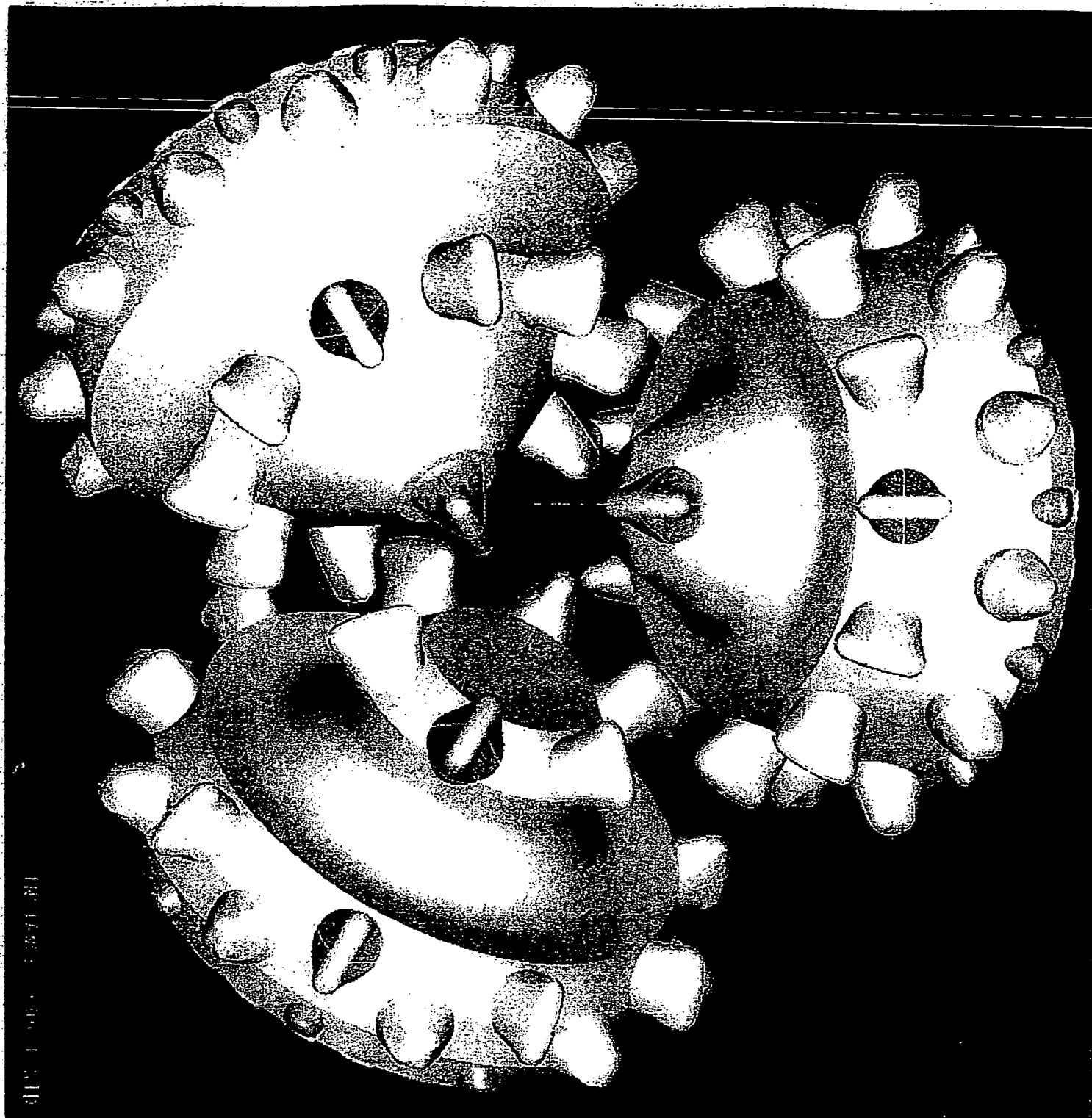
# PERFORMANCE OF F00 BIT IN BRITTLE ROCK OF INCREASING STRENGTH

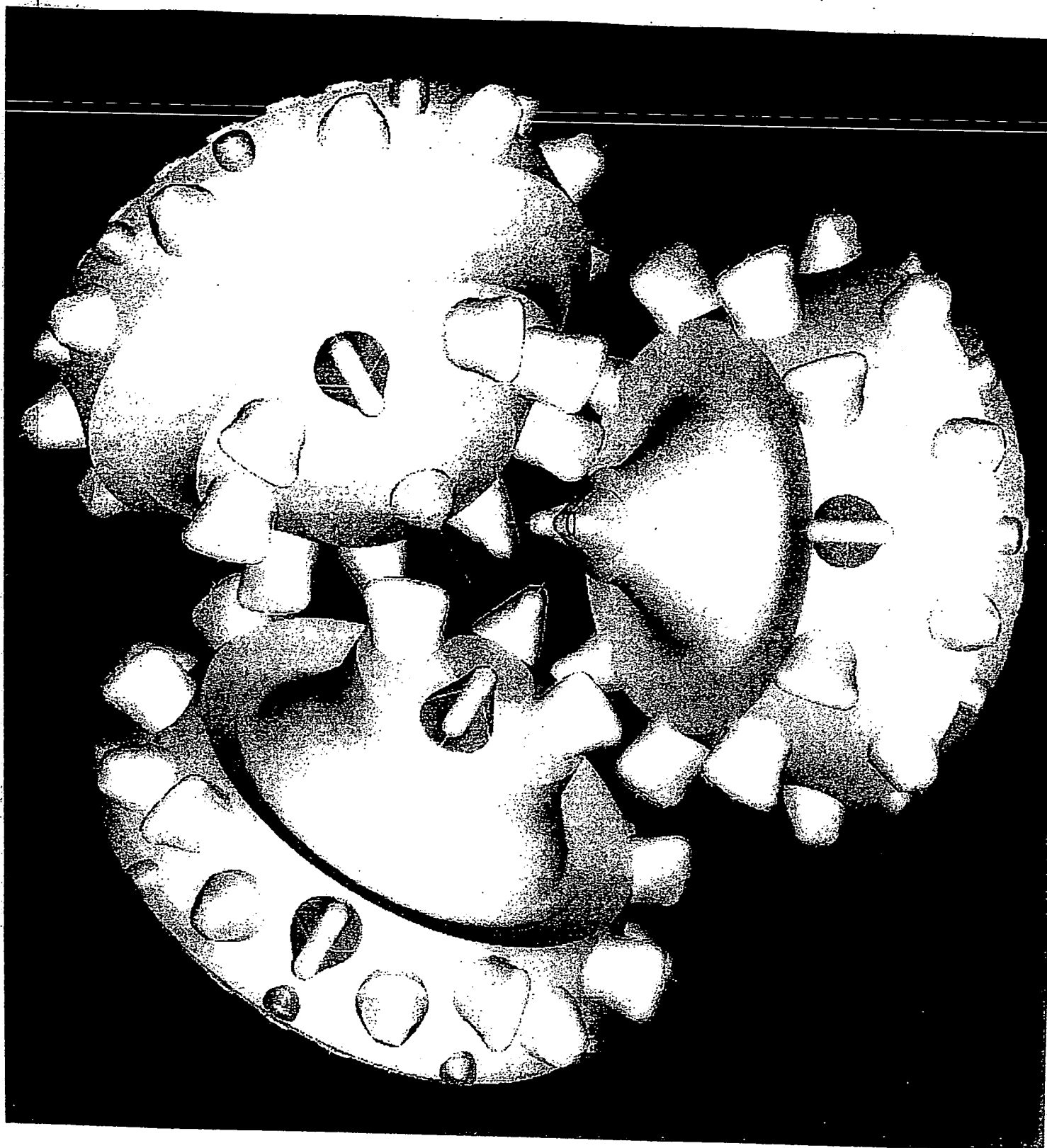
—●— R.O.P. COVERAGE



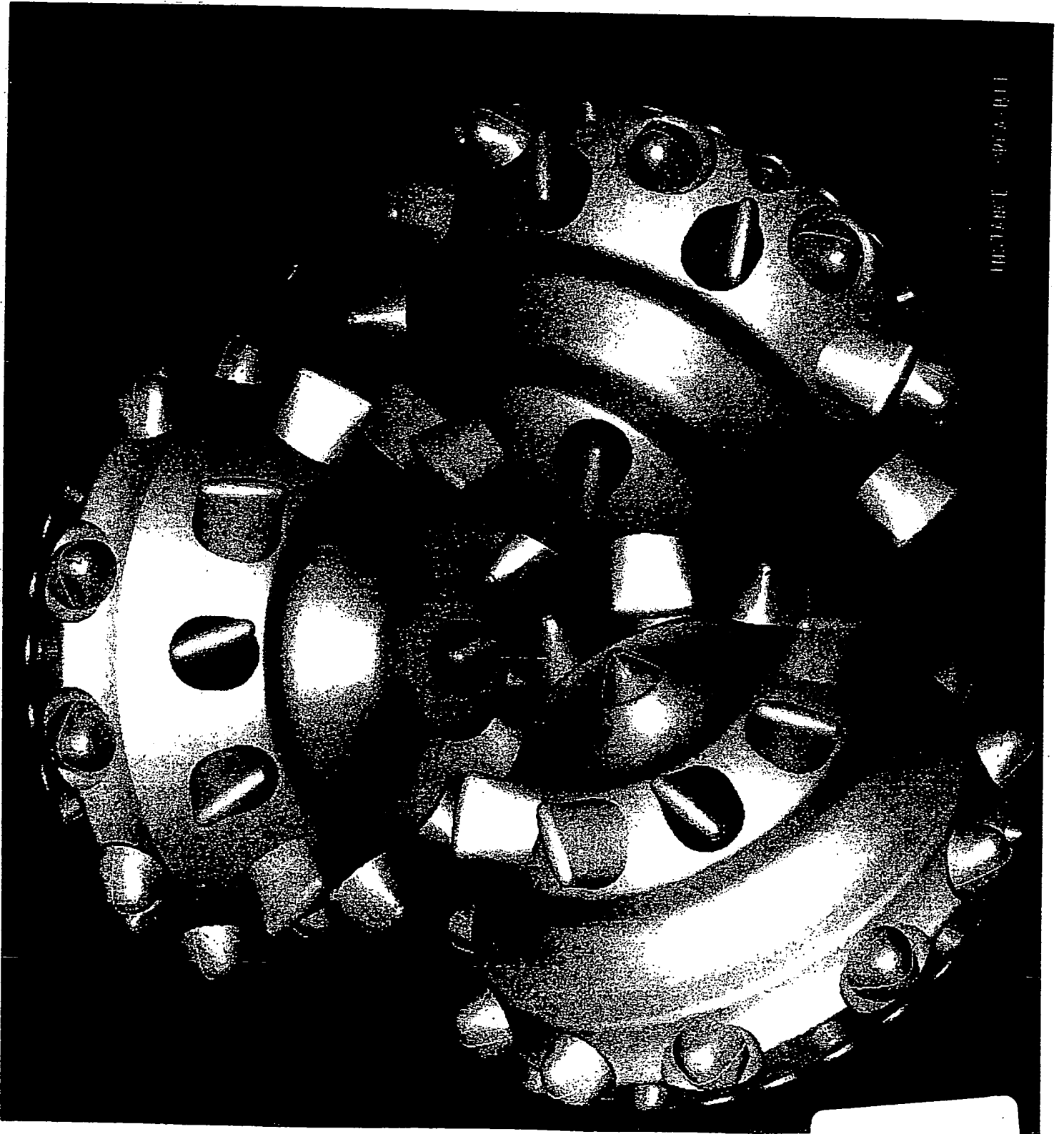
**BIT TYPE: F00-1 STD**  
**ROCK: DUCTILE**







110-506-1307-11



Stress Max Prin (Maximum)

Avg. Max +2.0036E+05

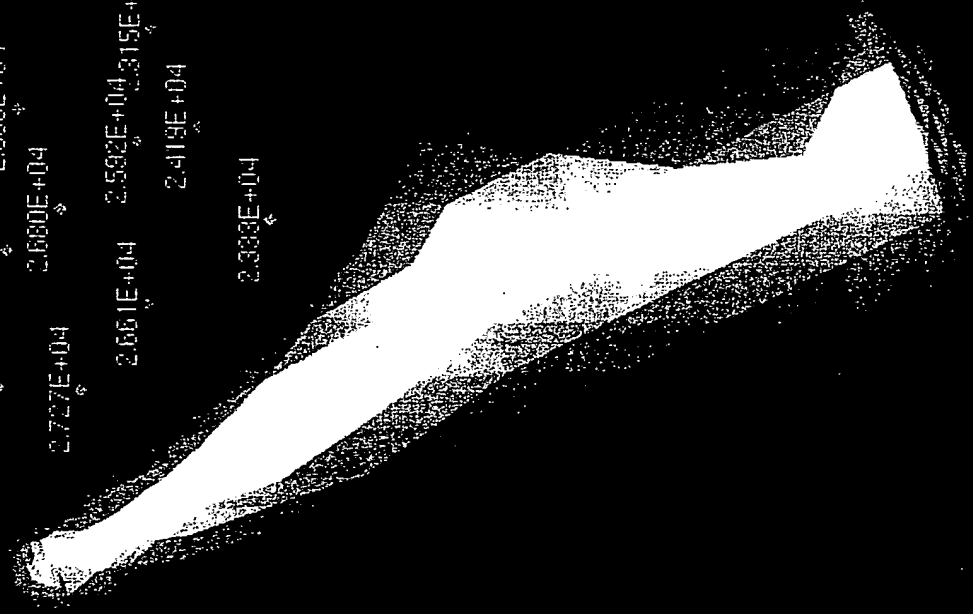
Avg. Min -7.0105E+04

Original Model

Load: load1

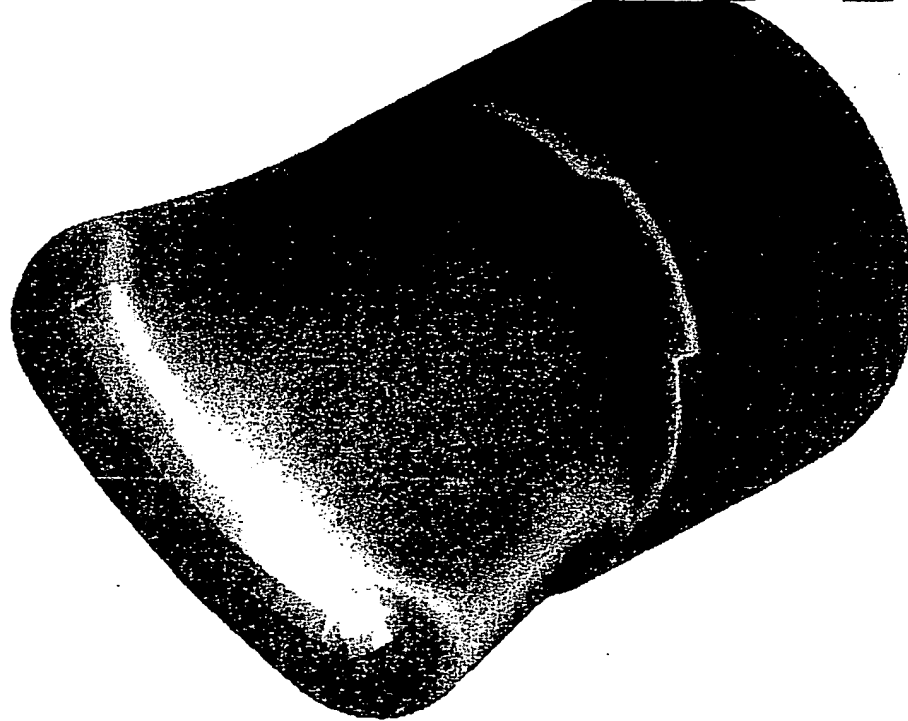
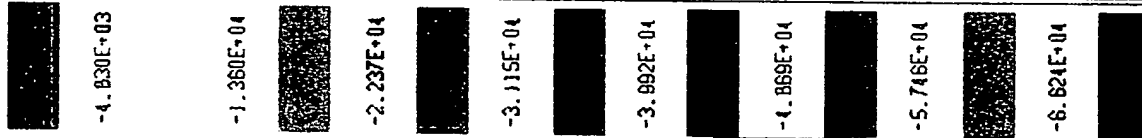
2.208E+04 2.682E+04  
2.562E+04 2.684E+04  
2.727E+04 2.588E+04  
2.680E+04 2.588E+04  
2.661E+04 2.592E+04  
2.333E+04 2.315E+04  
2.413E+04

+1.553E+05  
+1.102E+05  
+6.513E+04  
+2.005E+04  
-2.503E+04



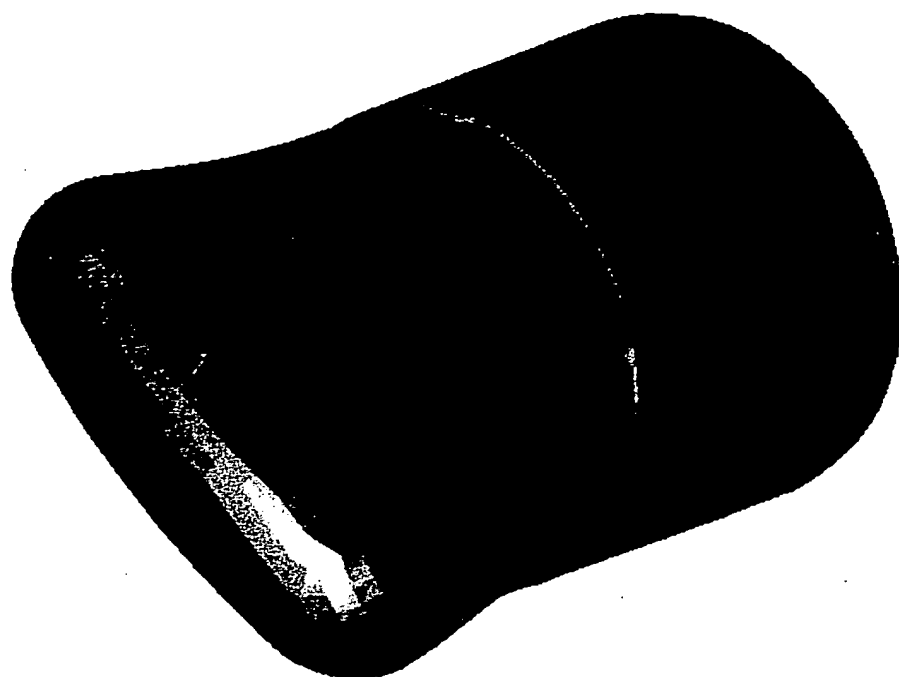
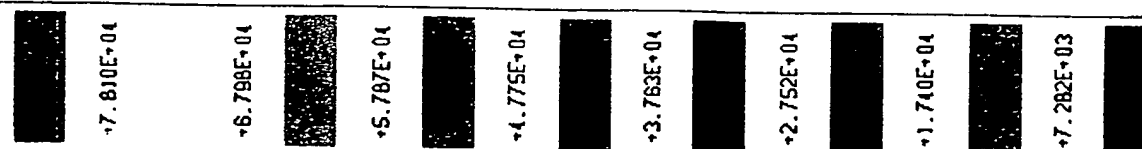
"window2" - odc\_press - odc\_press

Stress Min Prin (Minimum)  
 Avg. Max +3.9428E+03  
 Avg. Min -7.5009E+04  
 Original Model  
 Load: load1



"window2" - ins\_iceman1 - ins\_iceman1

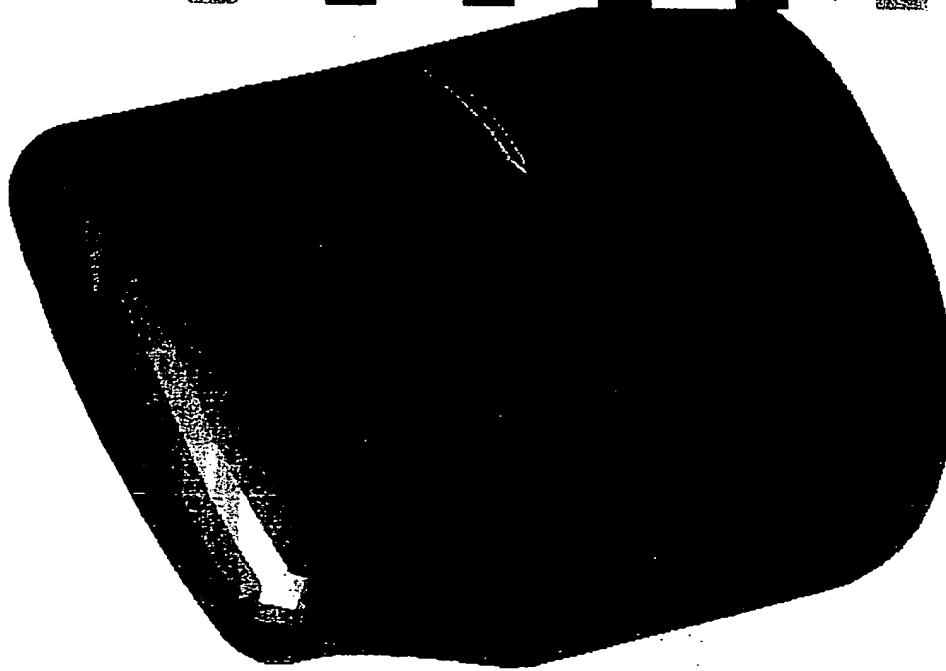
Stress Max Prin (Maximum)  
 Avg. Max +8.8219E+04  
 Avg. Min -2.8357E+03  
 Original Model  
 Load: load1



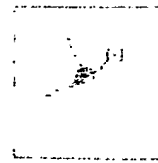
"window1" - ins\_iceman1 - ins\_iceman1



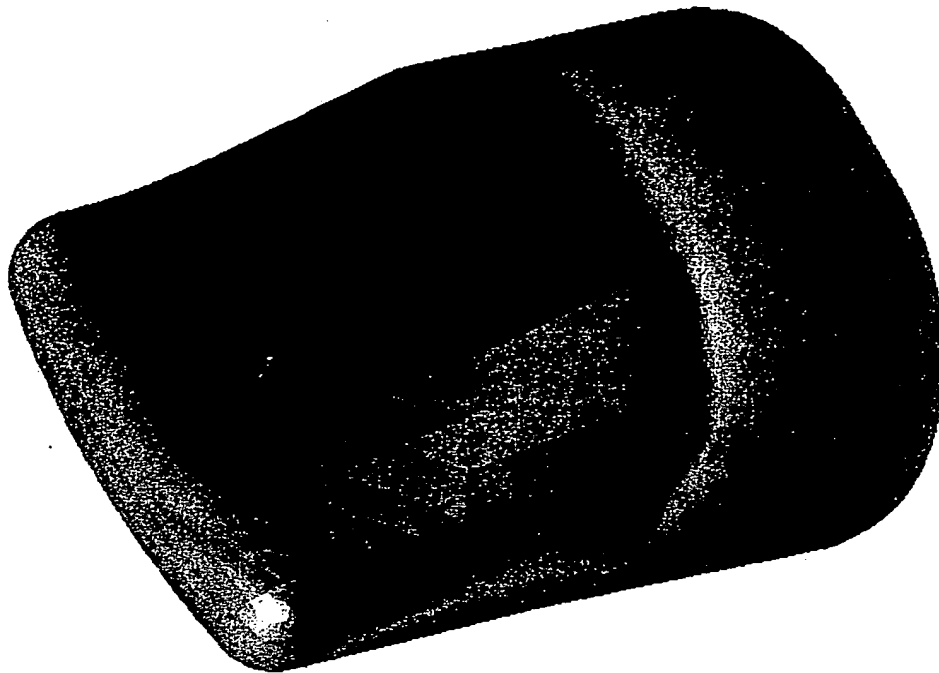
Stress Max Prin (Maximum)  
 Avg. Max: +9.9275E+04  
 Avg. Min: -2.4143E+03  
 Original Model  
 Load: load1



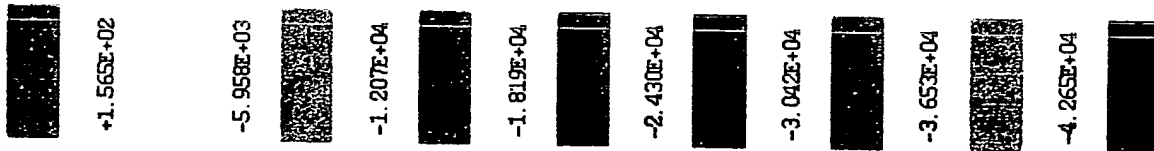
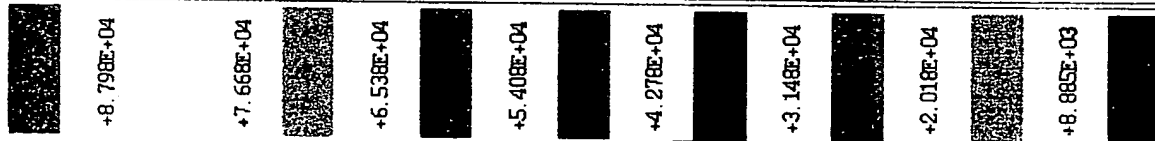
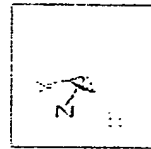
"window1" - OFFSET - OFFSET



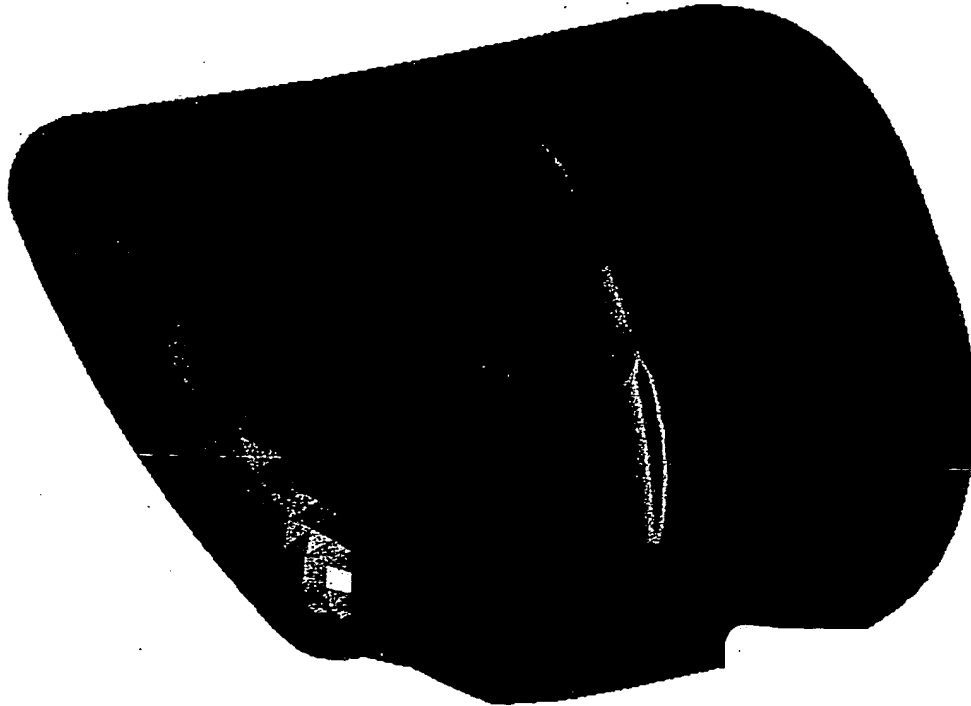
Stress Min Prin (Minimum)  
 Avg. Max: +6.2710E+03  
 Avg. Min: -4.8760E+04  
 Original Model  
 Load: load1



"window2" - OFFSET - OFFSET

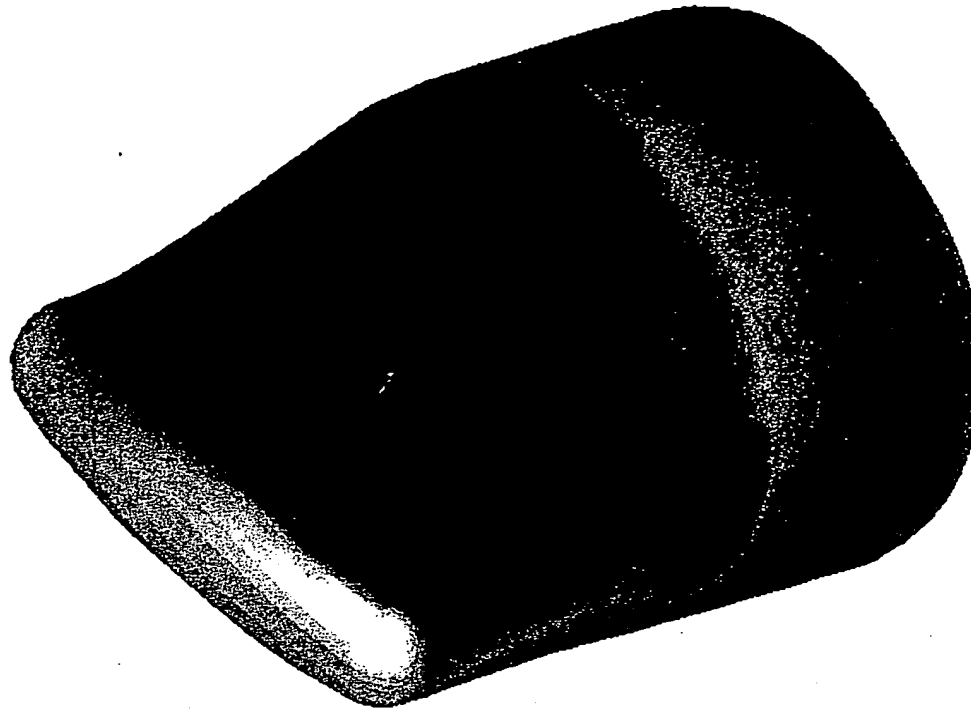


Stress Max Prin (Maximum)  
 Avg. Max +1.2738E+05  
 Avg. Min -2.4160E+03  
 Original Model  
 Load: load1

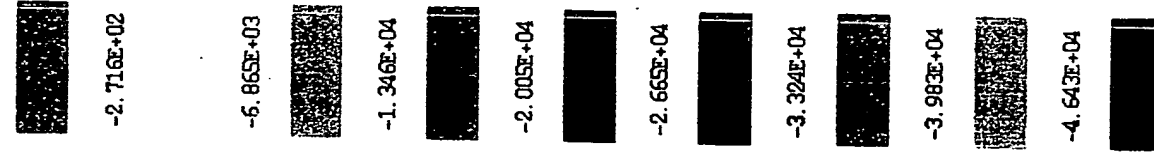
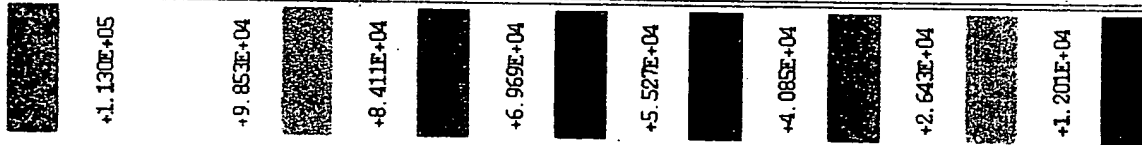


"window1" - ins\_bend\_0 - ins\_bend\_0

Stress Min Prin (Minimum)  
 Avg. Max +6.3221E+03  
 Avg. Min -5.3021E+04  
 Original Model  
 Load: load1



"window2" - ins\_bend\_0 - ins\_bend\_0



Stress 3d (top)  
Max -1.817E-01  
Min -5.513E-02  
Original Model  
Load: load1

+1.510E+04  
+1.202E+04  
+8.943E+03  
+5.007E+03  
+2.791E+03  
-2.848E+02  
-3.361E+03  
-6.437E+03

Index1 - Inq\_band - Inq\_band

Stress 3d (top)  
Max -6.420E-01  
Min -2.723E-02  
Original Model  
Load: load1

+8.343E+04  
+7.266E+04  
+6.189E+04  
+5.112E+04  
+4.035E+04  
+2.958E+04  
+1.881E+04  
+8.037E+03

Index1 - Inq\_band - Inq\_band

Stress 3d (top)  
Max -2.040E-04  
Min -1.372E-04  
Original Model  
Load: load1

+1.667E+04  
+1.287E+04  
+9.066E+03  
+5.266E+03  
+1.466E+03  
-2.334E+03  
-6.134E+03  
-9.934E+03

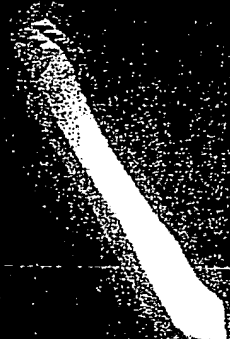
Index2 - Inq\_load - Inq\_load

Stress 3d (top)  
Max -1.508E-05  
Min -5.403E-05  
Original Model  
Load: load1

+1.366E+05  
+1.206E+05  
+1.027E+05  
+8.466E+04  
+6.065E+04  
+4.661E+04  
+3.058E+04  
+1.255E+04

Index1 - Inq\_load - Inq\_load

Stress EE (loop)  
Max = 7.225E+04  
Min = 2.112E+03  
Original Model  
Load = load



+6.275E+04

+5.226E+04

+4.176E+04

+3.129E+04

+2.080E+04

+1.032E+04

-1.640E+02

-1.066E+04

\*Indo2\* - Info\_Loan - Info\_Loan

Stress EE (loop)  
Max = 2.380E+04  
Min = 1.017E+03  
Original Model  
Load = load

+1.801E+04

+1.333E+04

+6.639E+03

+3.953E+03

-7.327E+02

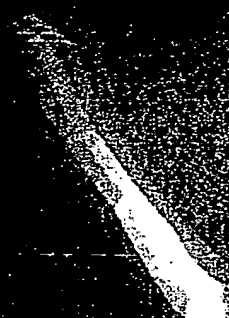
-5.419E+03

-1.010E+04

-1.479E+04

\*Indo2\* - Info\_Loan - Info\_Loan

Stress Max Pr in (loop)  
Max = 1.583E+05  
Min = 5.482E+03  
Original Model  
Load = load



+1.388E+05

+1.208E+05

+1.027E+05

+8.466E+04

+6.665E+04

+4.661E+04

+3.058E+04

+1.255E+04

\*Indo2\* - Info\_Loan - Info\_Loan

Stress Max Pr in (loop)  
Max = 9.420E+04  
Min = 2.722E+02  
Original Model  
Load = load

+6.343E+04

+7.266E+04

+6.169E+04

+5.112E+04

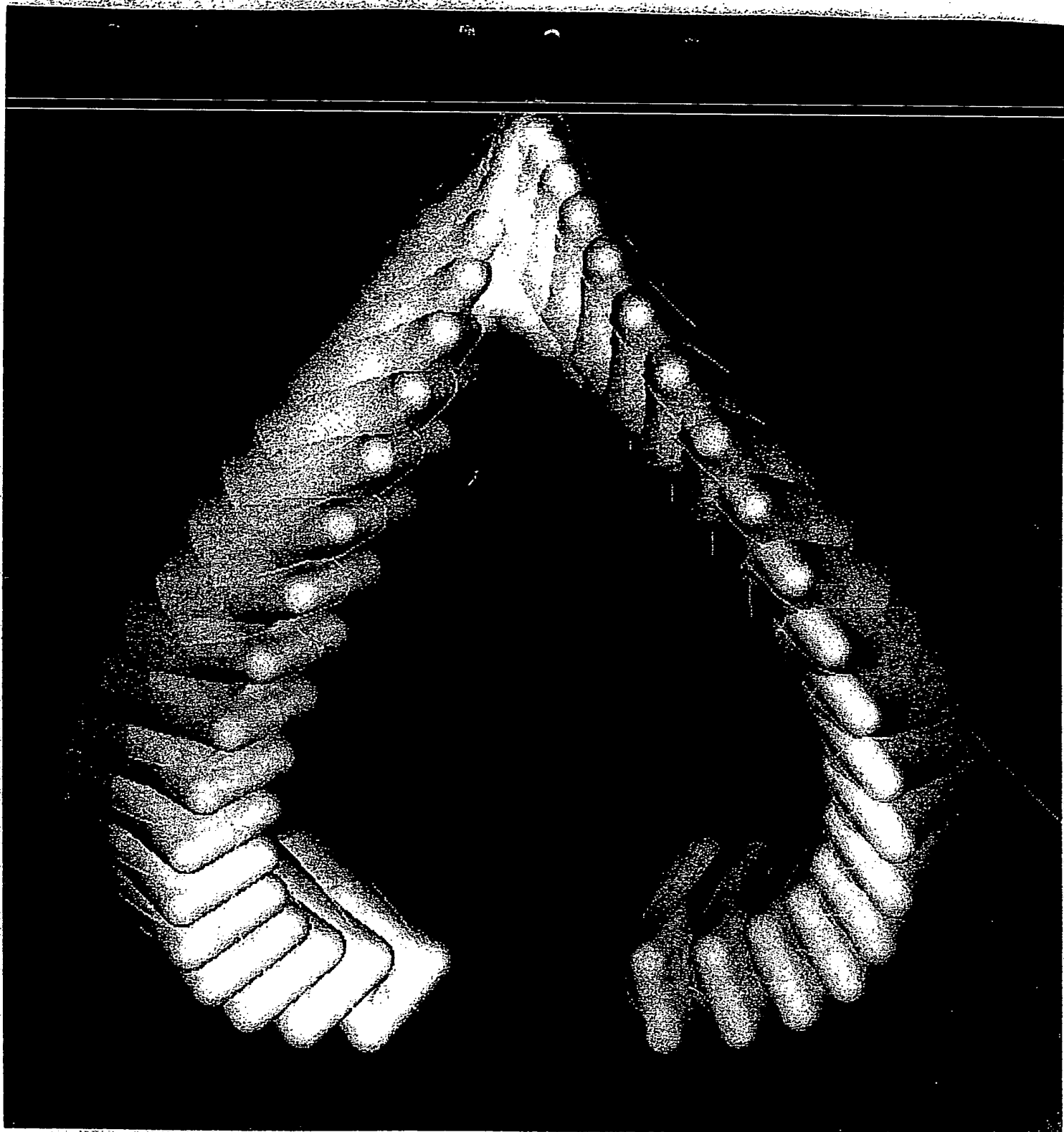
+4.035E+04

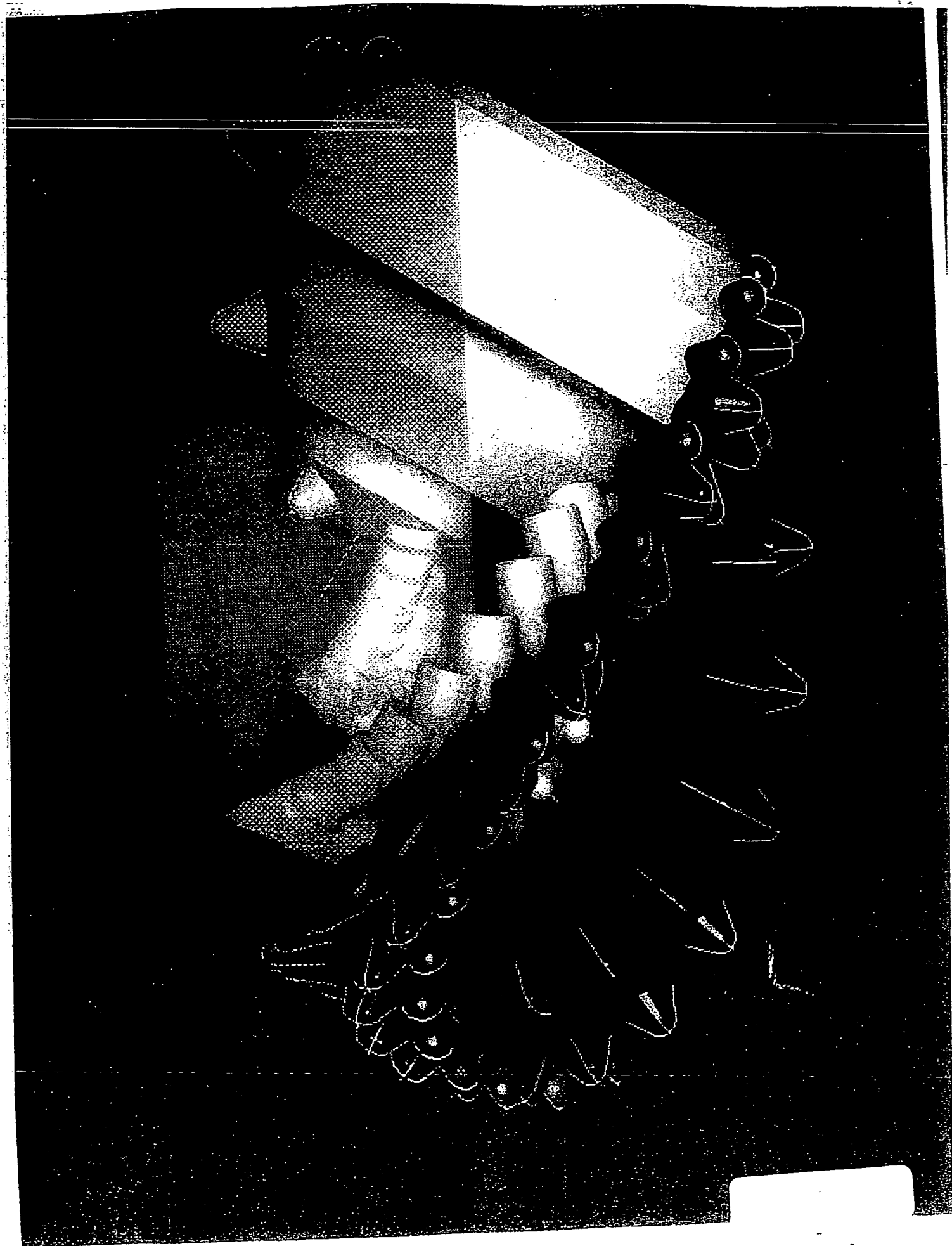
+2.958E+04

+1.881E+04

+8.037E+03

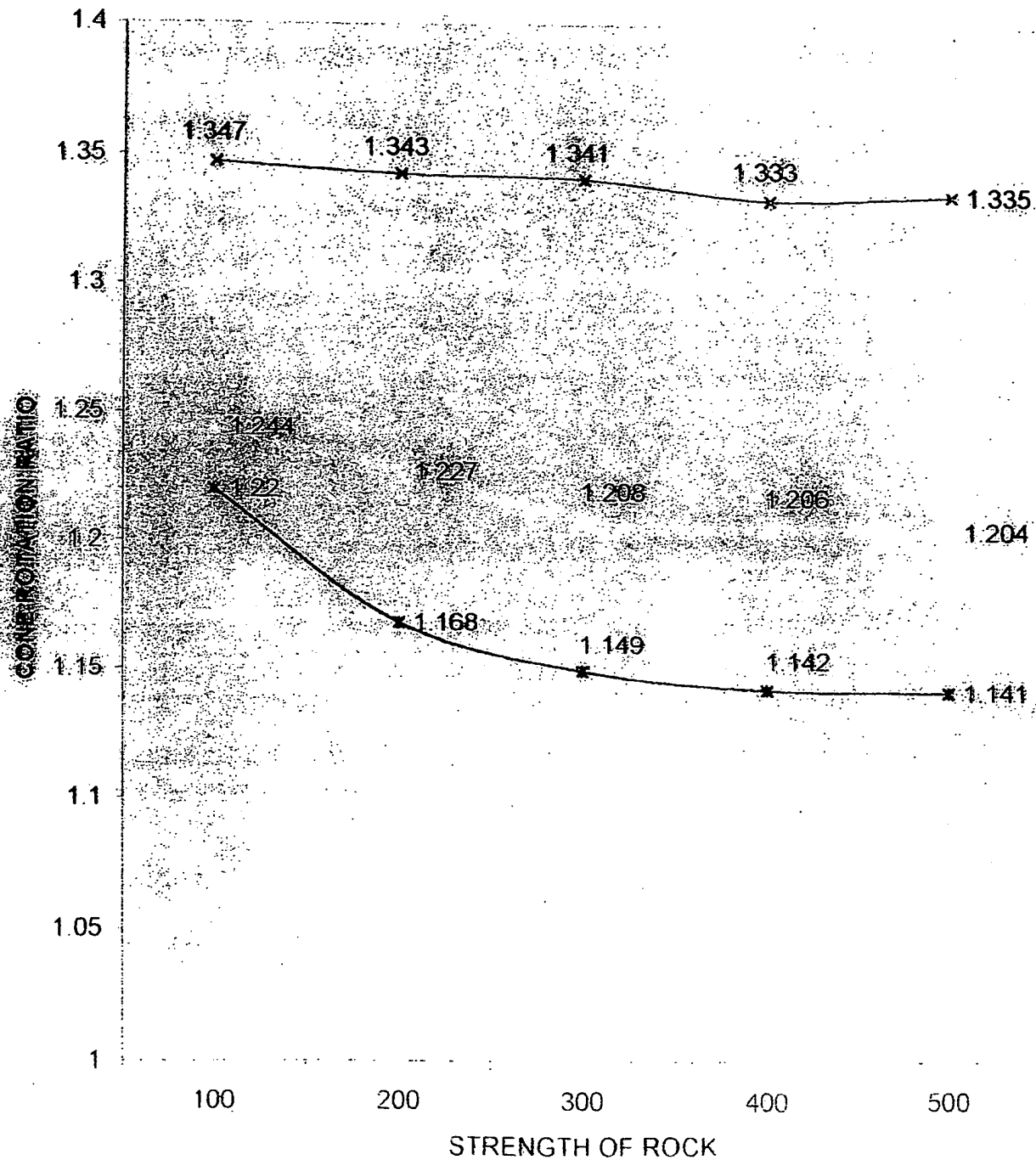
\*Indo2\* - Info\_Loan - Info\_Loan





# PERFORMANCE OF F00 BIT IN DUCTILE ROCK OF INCREASING STRENGTH

CONE1 \* CONE2 \* CONE3

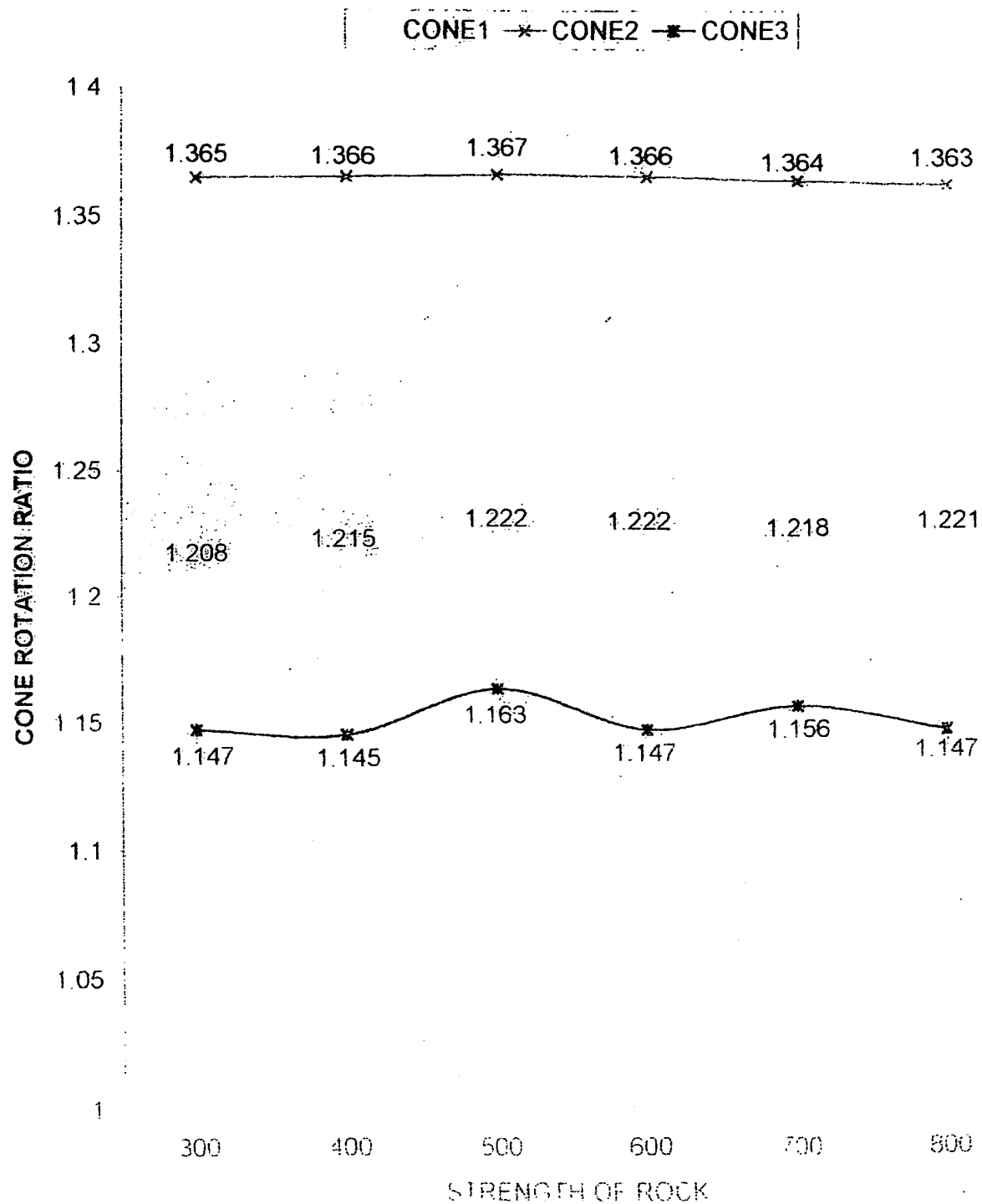


**BIT TYPE:**

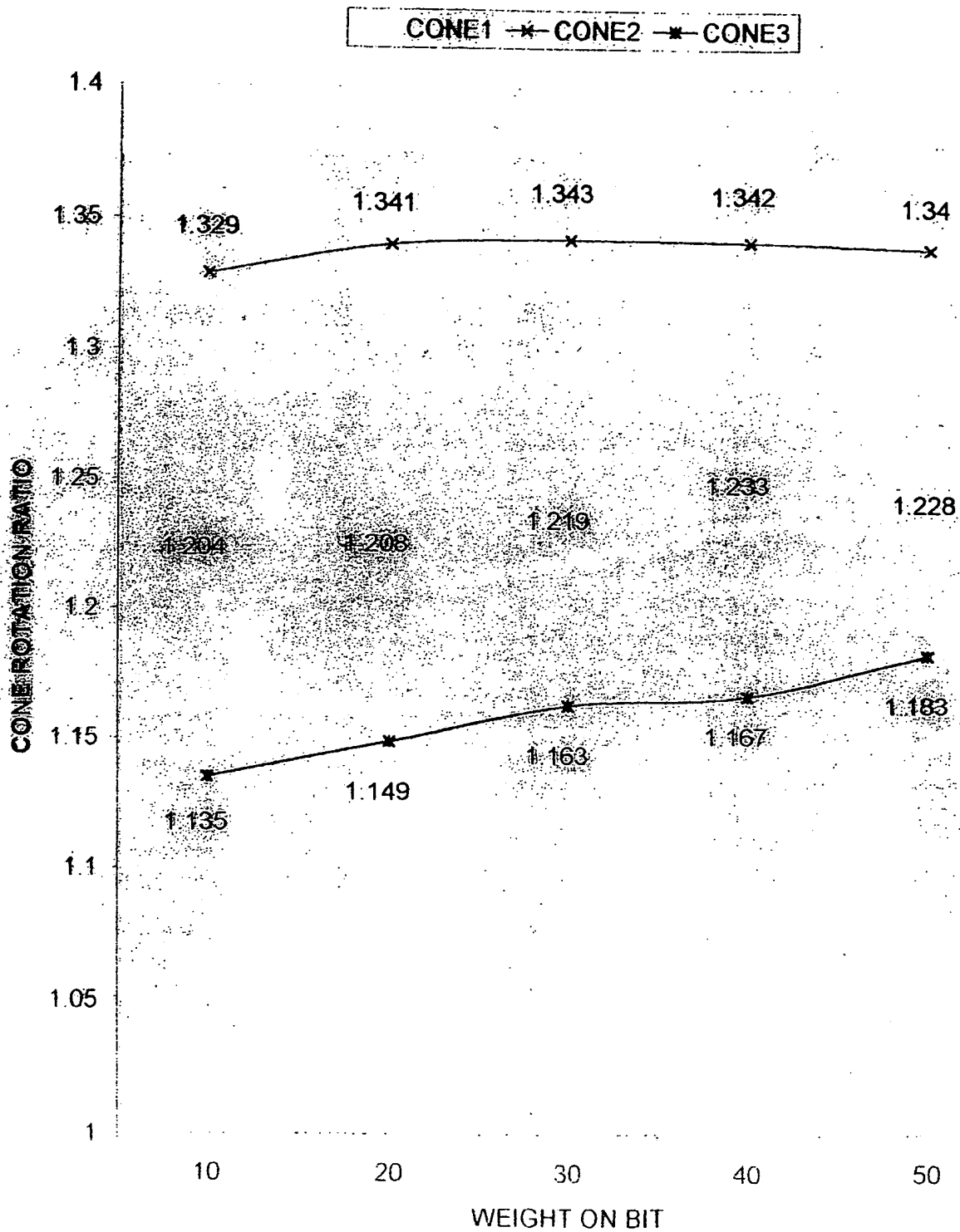
**ROCK: BRITTLE**



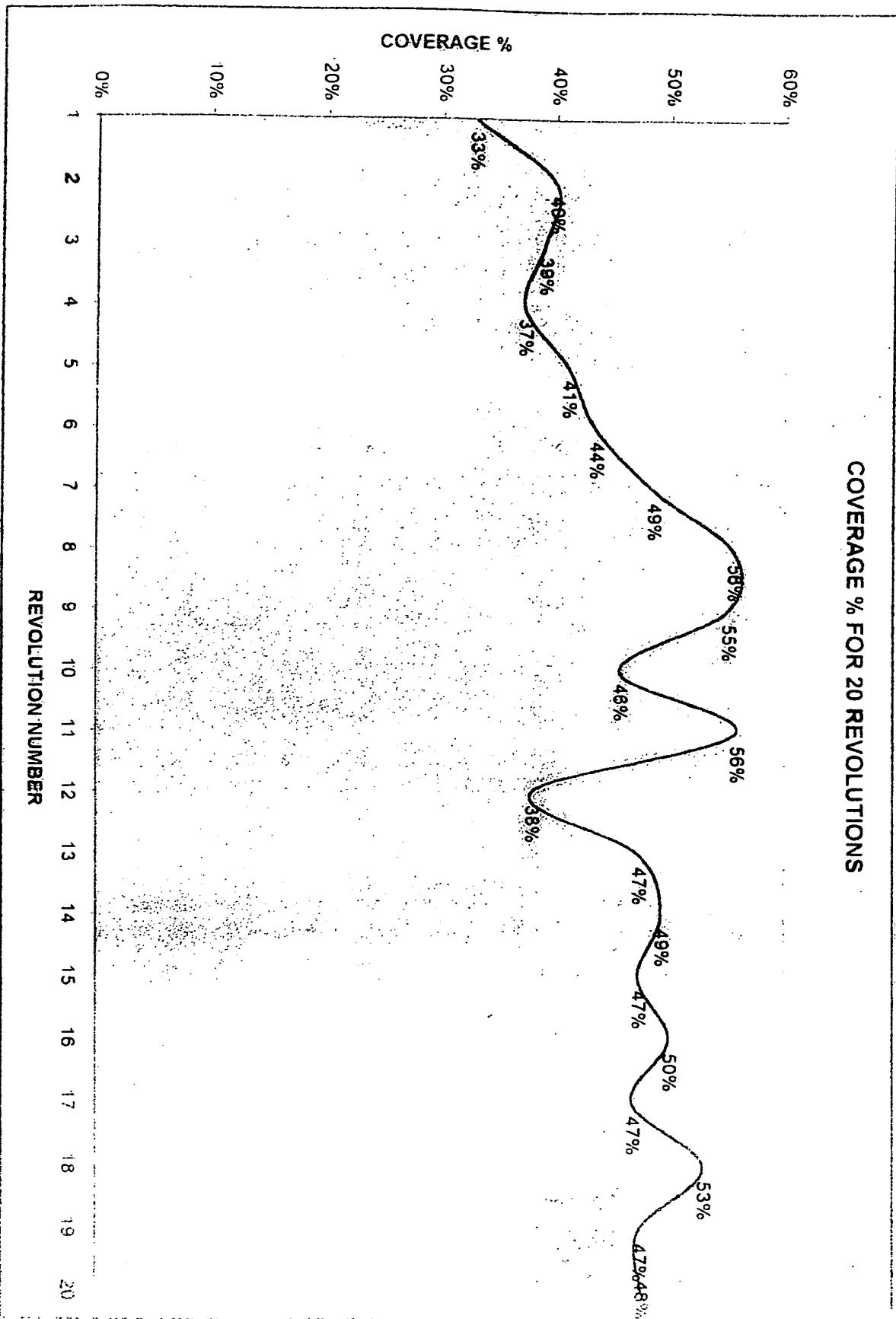
PERFORMANCE OF F00 BIT IN BRITTLE ROCK OF INCREASING STRENGTH



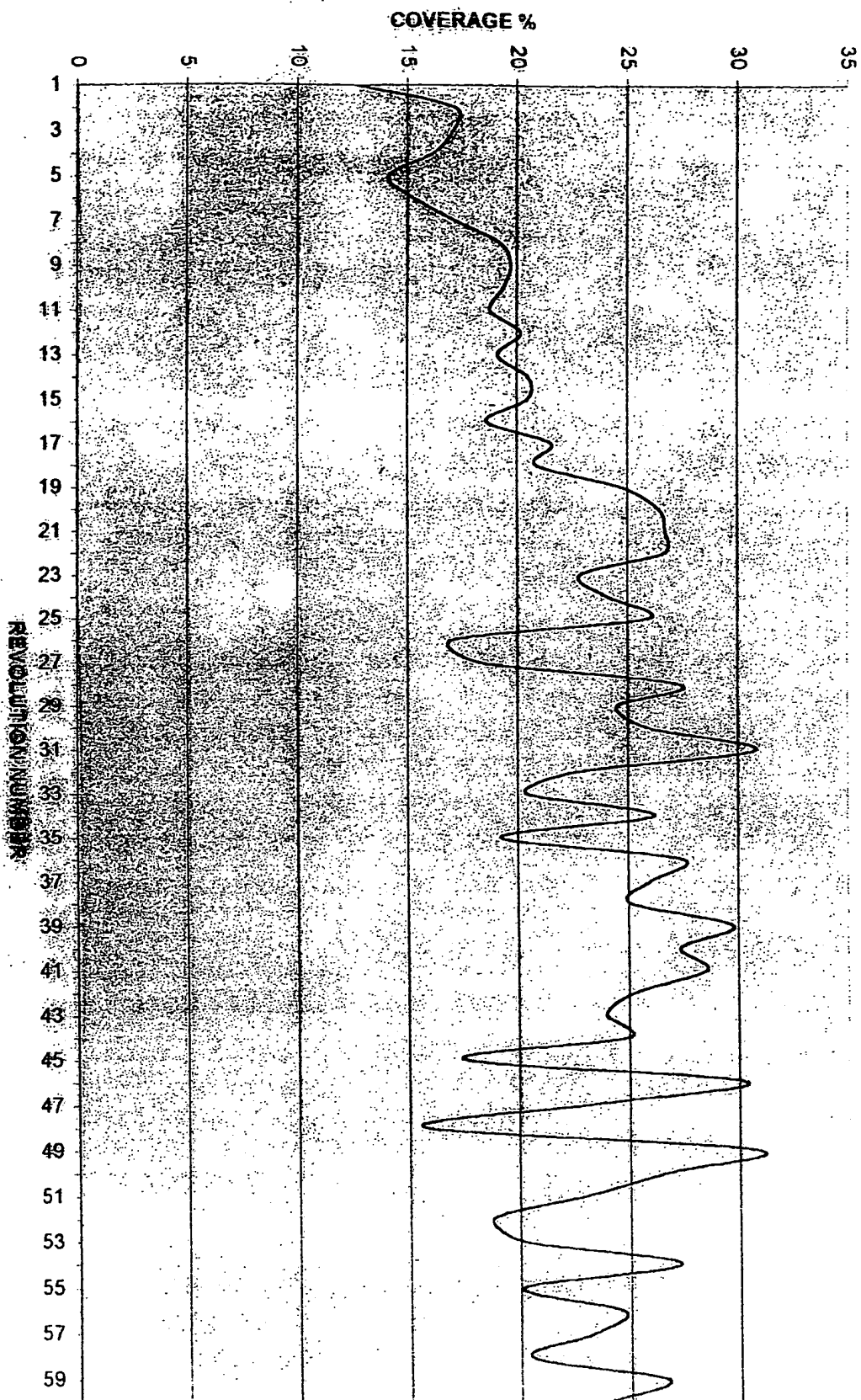
# PERFORMANCE OF F00 BIT IN MEDIUM DUCTILE ROCK



# COVERAGE % FOR 20 REVOLUTIONS

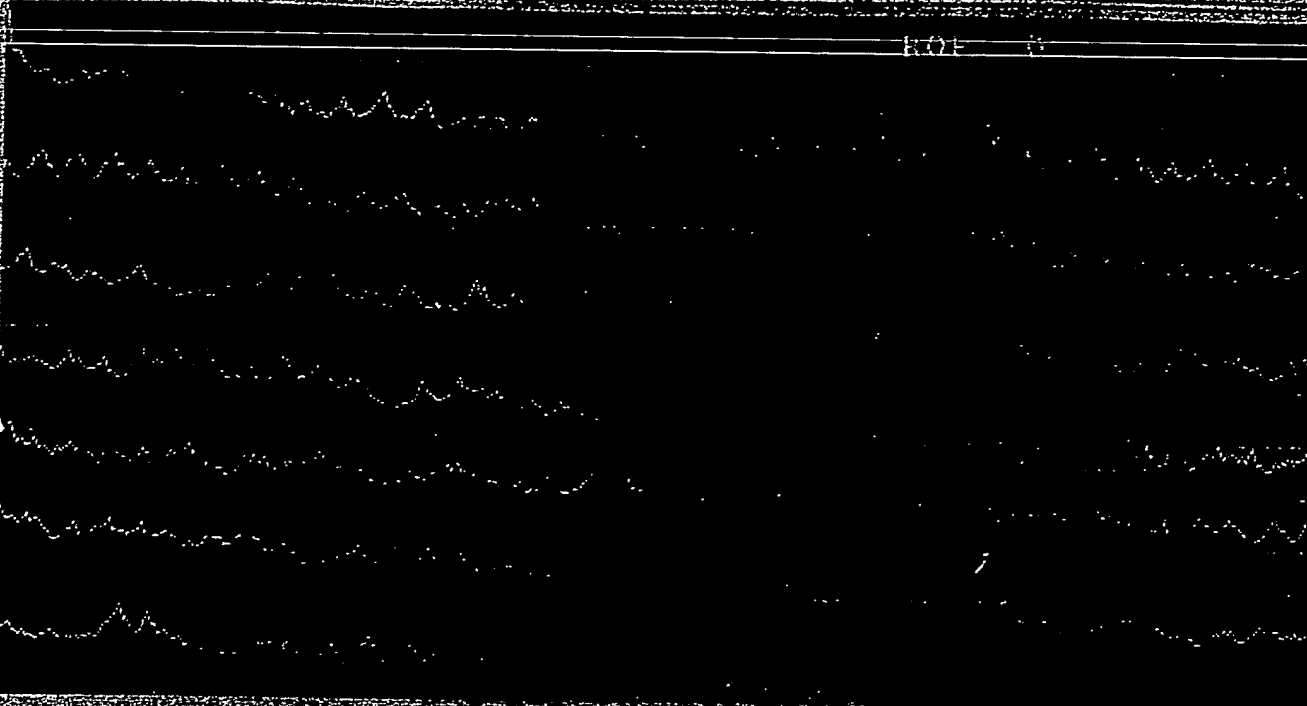


COVERAGE OF F00 BIT IN HARD DUCTILE ROCK



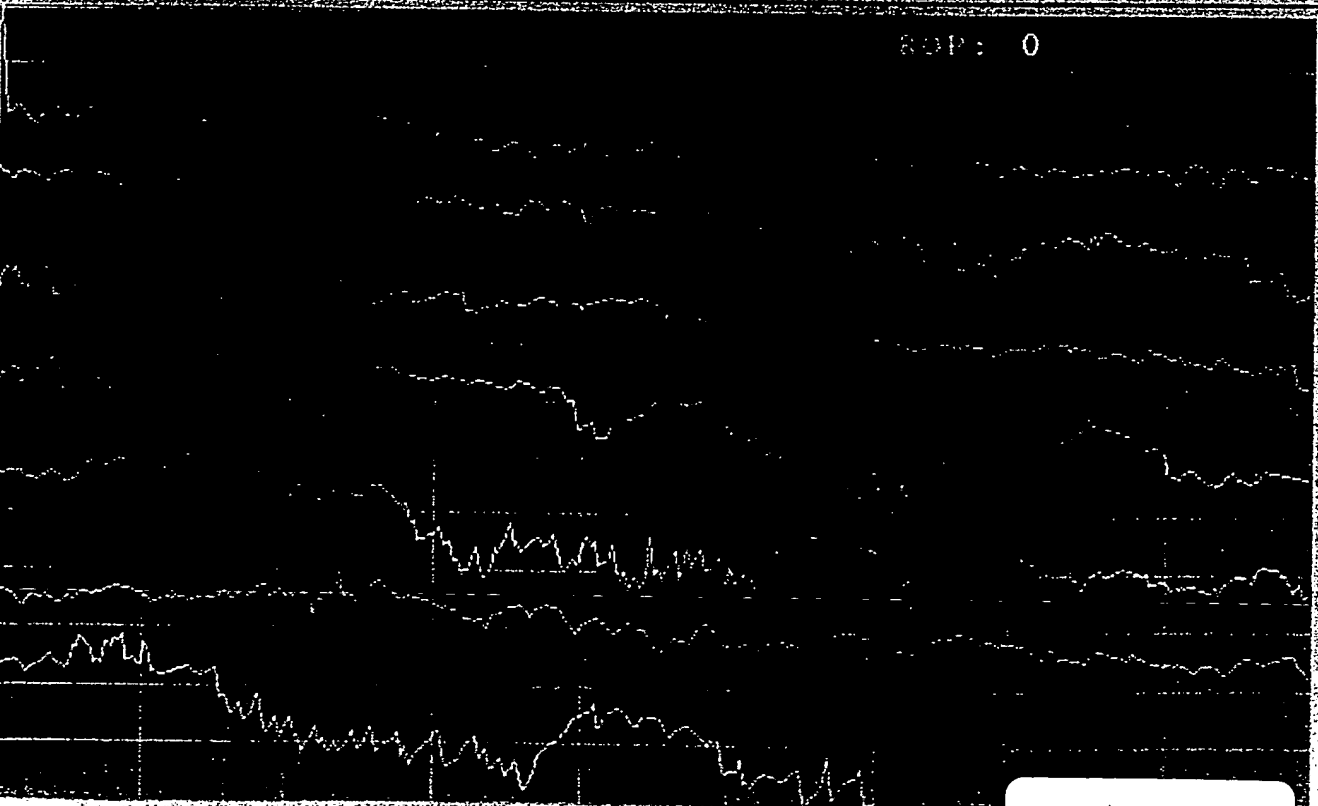
Drilling Depth

BRITTLE ROCK

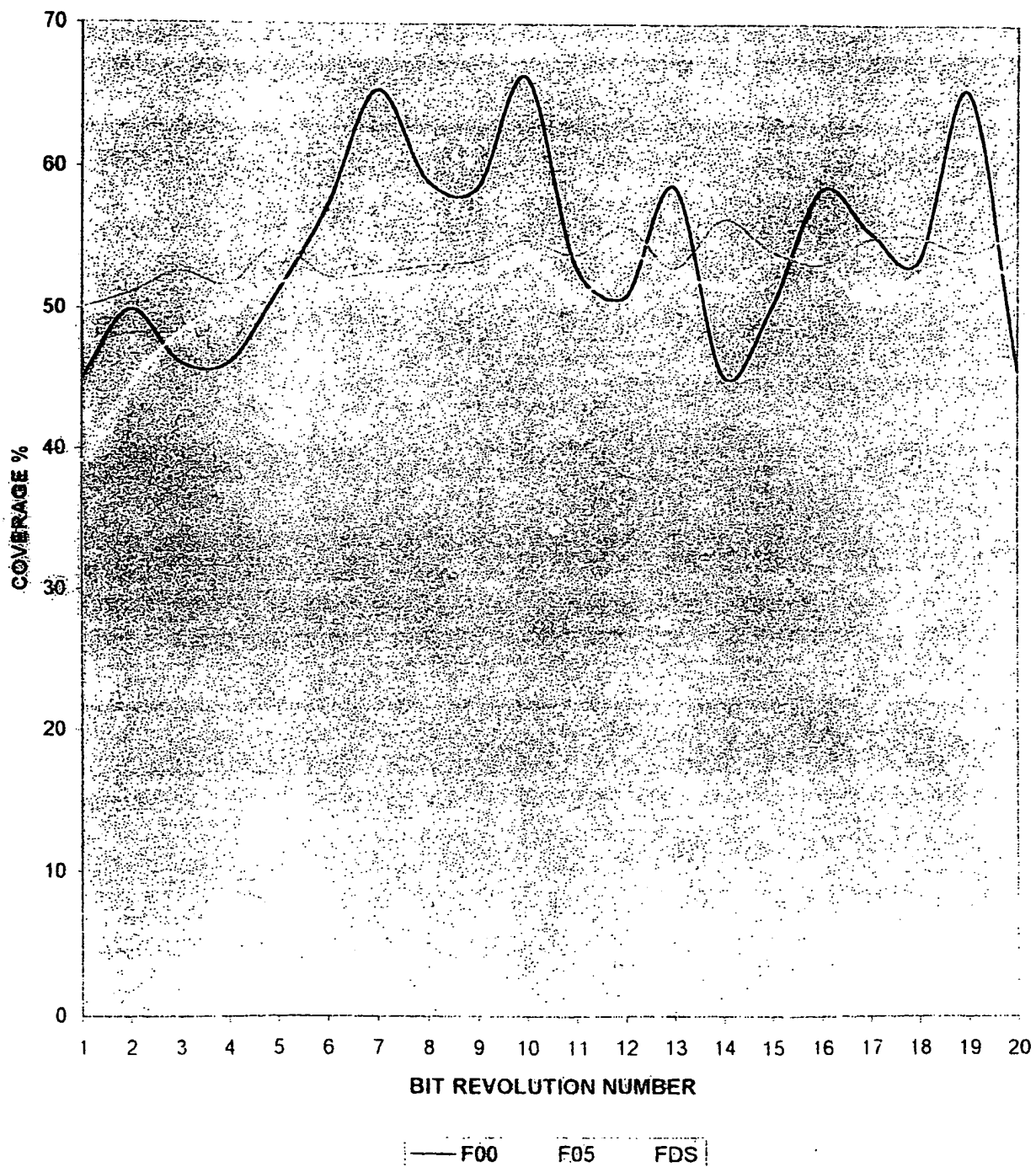


Drilling Depth

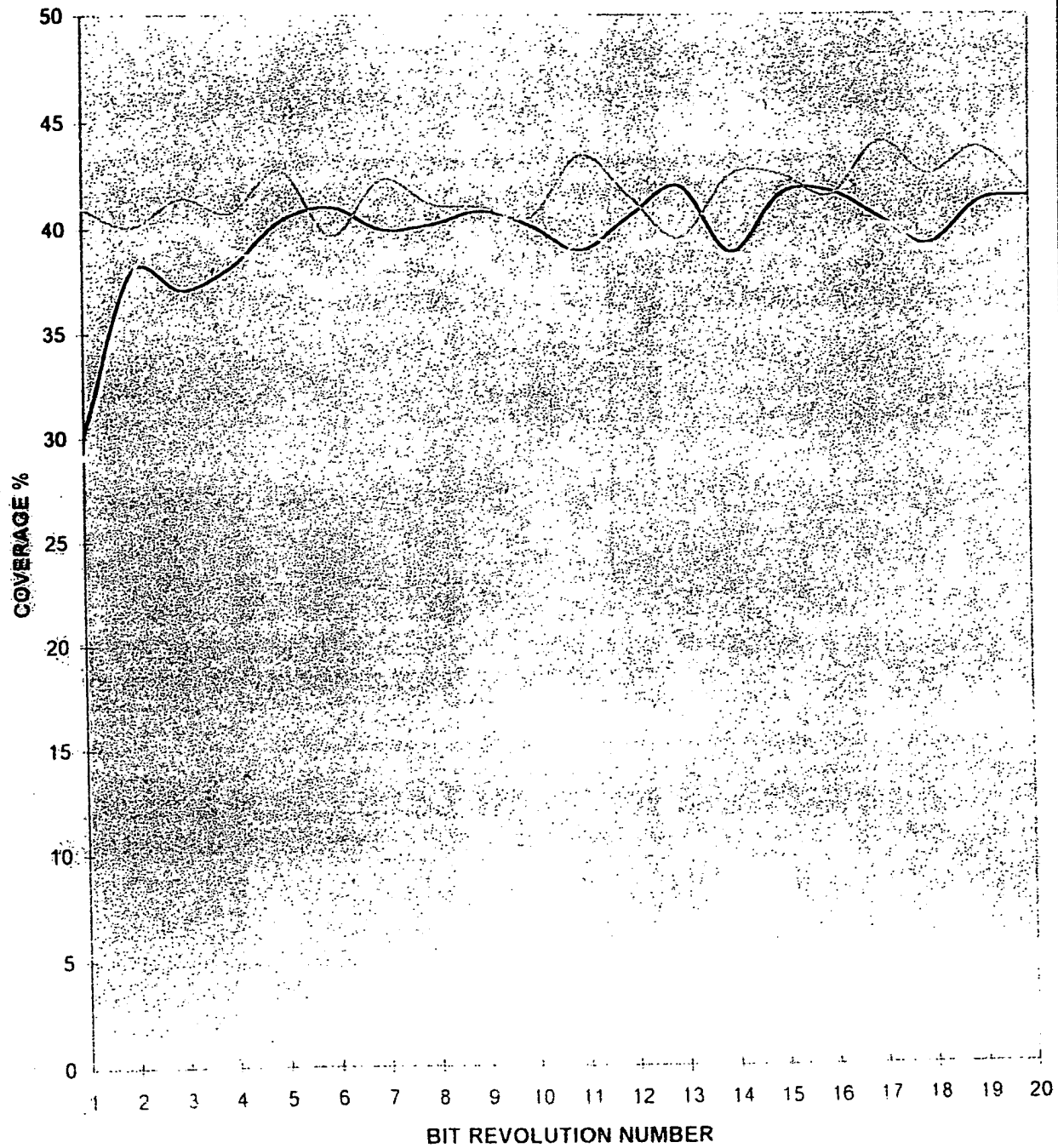
BUCHER ROCK



# COVERAGE OF F00 BIT VERSUS THE F05 AND FDS BITS IN DUCTILE ROCK



# COVERAGE OF F00 BIT VERSUS THE F05 AND FDS BITS IN BRITTLE ROCK



— F00    - - - F05    . . . FDS

**BIT TYPE: F00**  
**ROCK: BRITTLE**

